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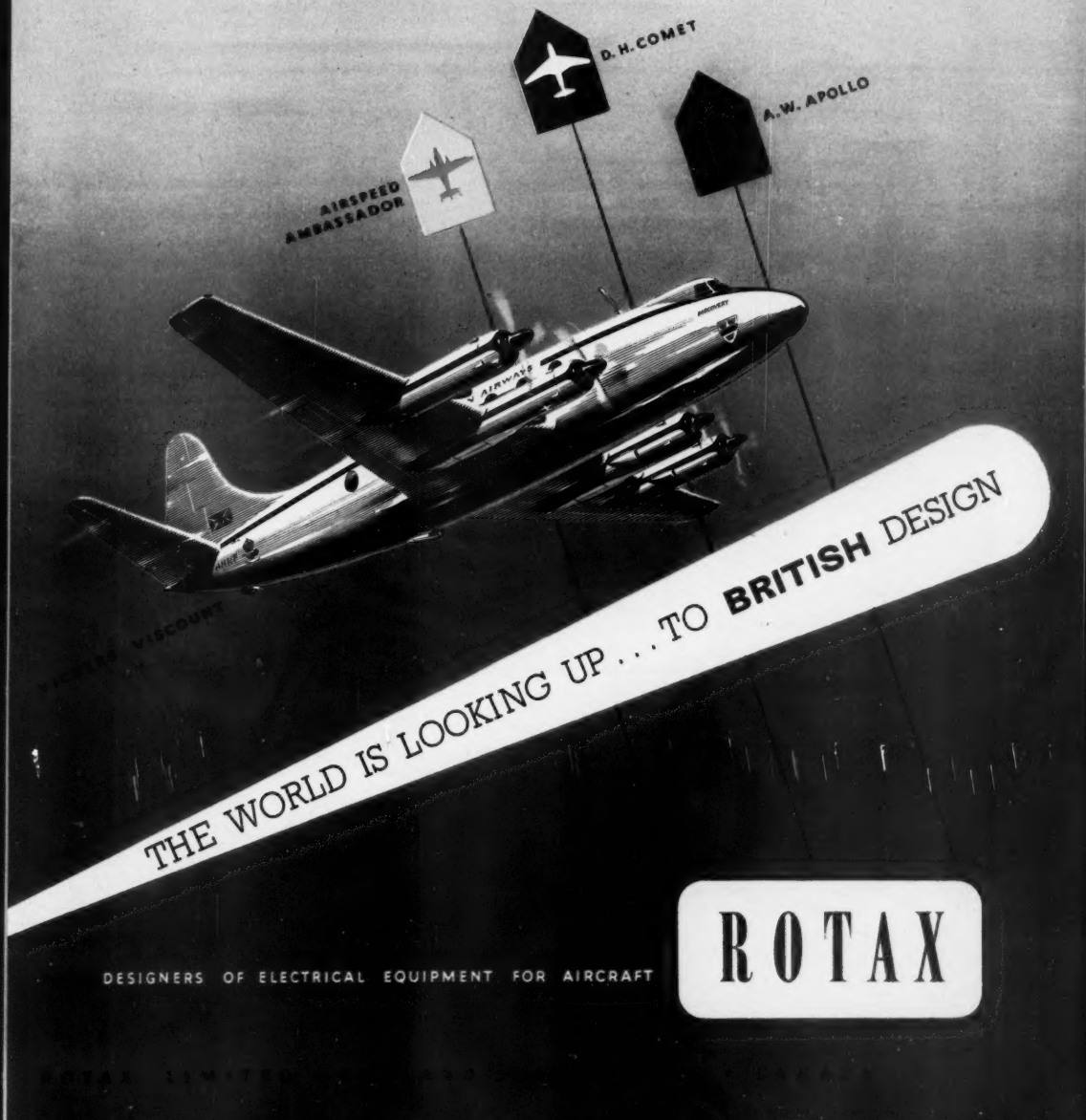
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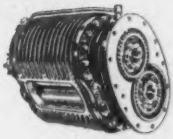

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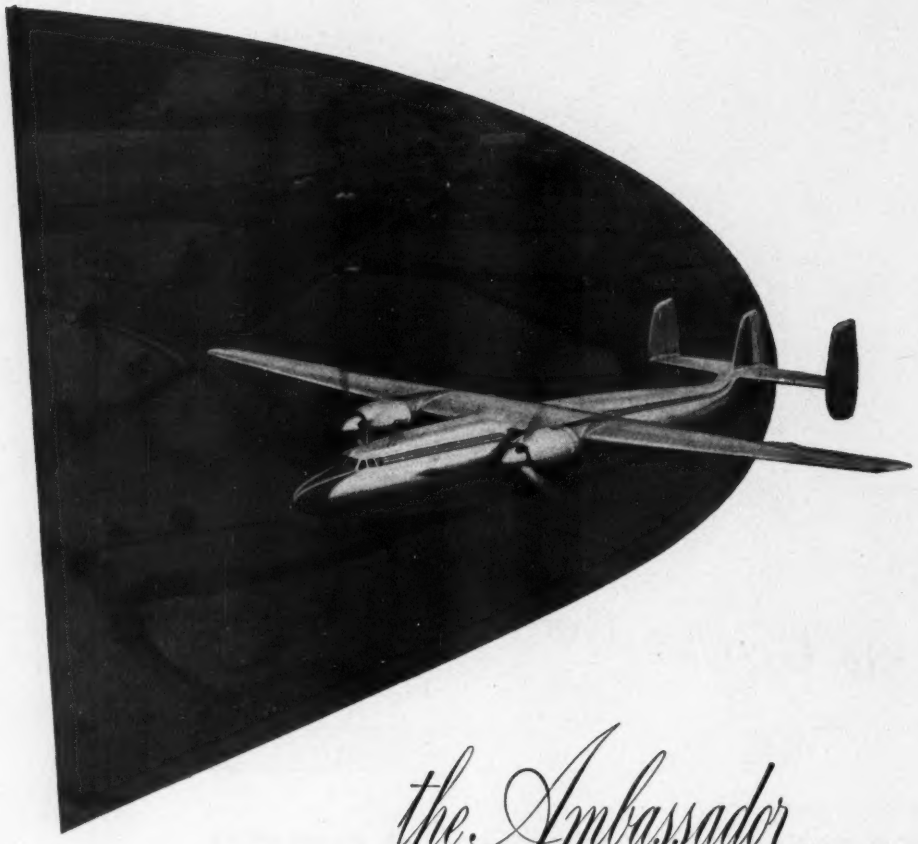

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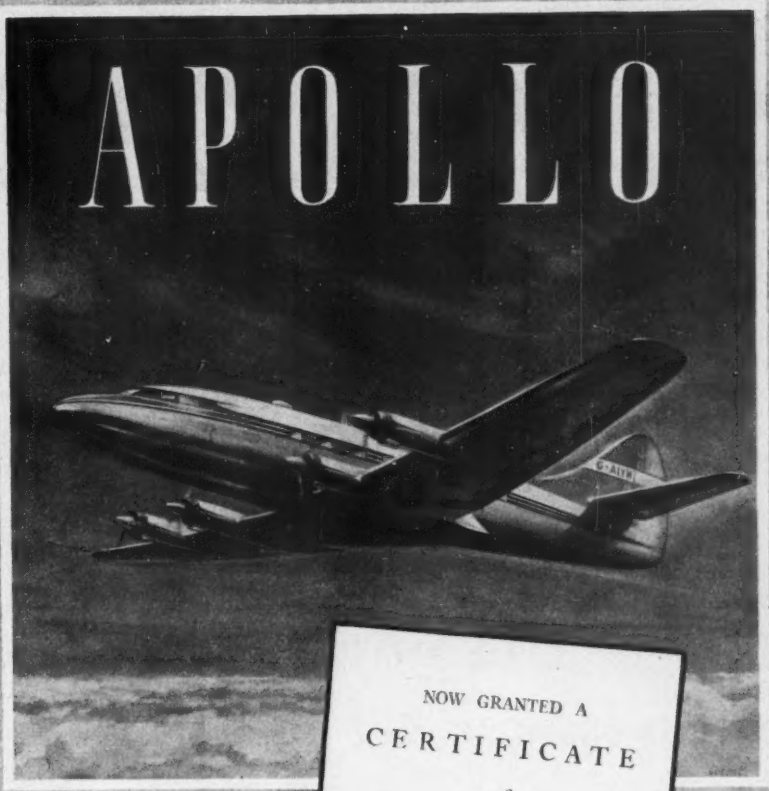

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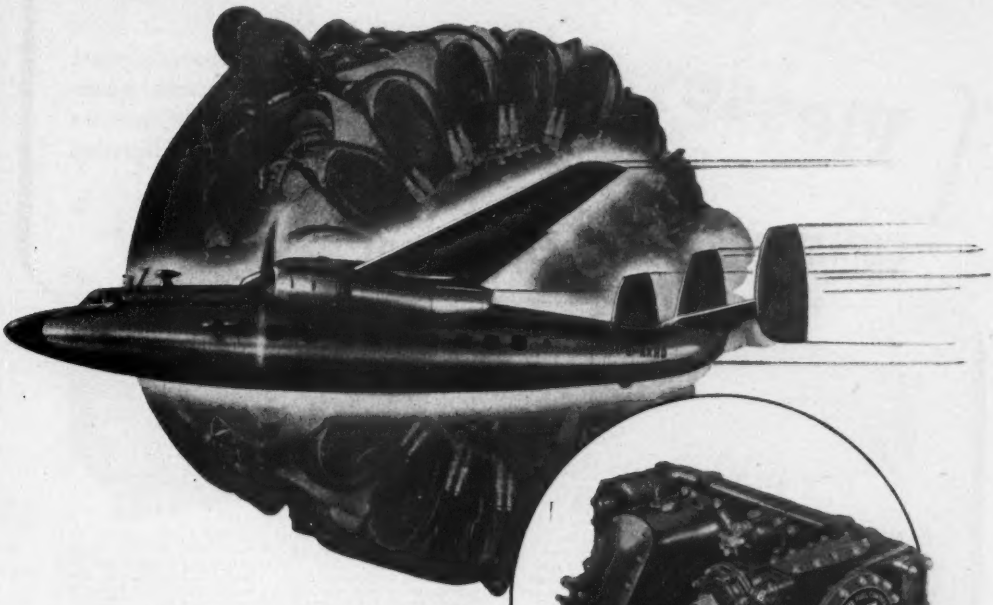

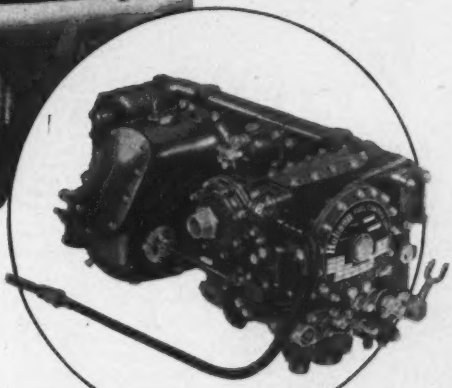

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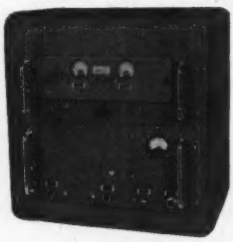

PT 10 12 watt V.H.F. crystal controlled transmitter covering the 116-132 Mc/s. band. Designed for simple operation with band pass circuits in the R.F. unit to reduce the number of tuning controls required, and a pre-set circuit in the modulator which automatically prevents over modulation.

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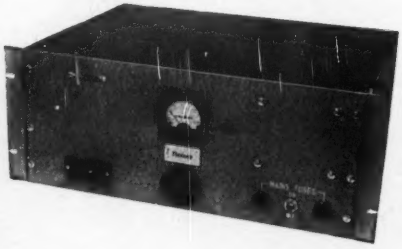

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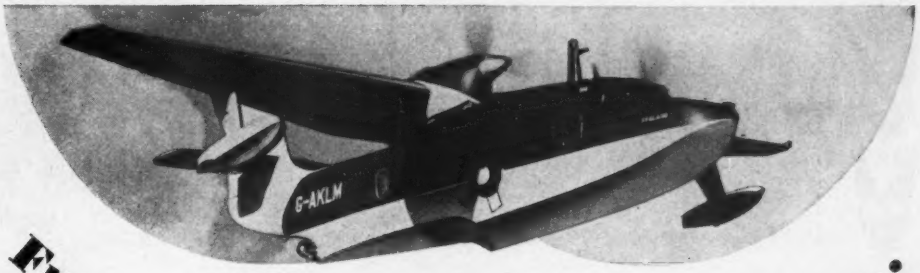
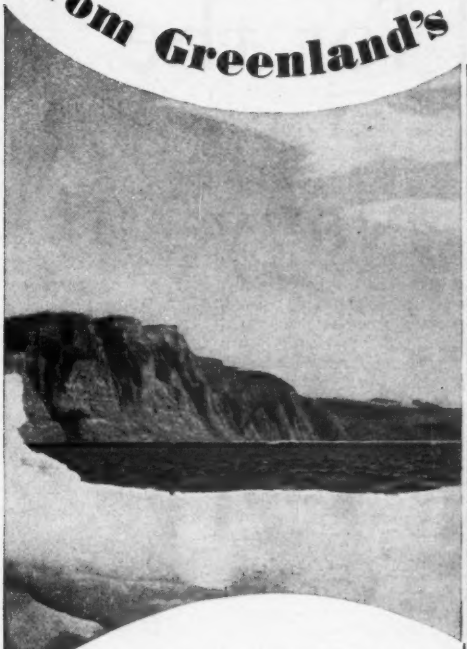
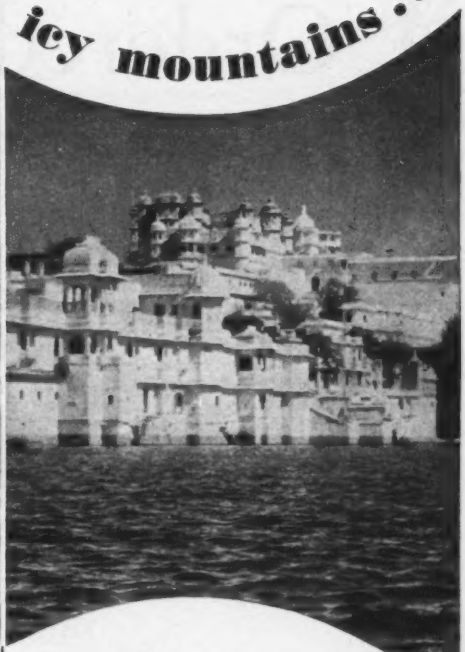


From Greenland's icy mountains . . .





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IN THIS ISSUE:

Hiller Hornet - - - - 206
Flight Research - - - 212
All-weather Fighter - - 215
Ferry to Ambassador - 217
Background to the Ambassador 229
B.E.A.'s Elizabethans - 232
Making Air Transport Pay 238

The Big Boats

NEVER, since T. O. M. Sopwith and Glenn Curtiss amazed the world with the Bat Boat and Hydro, has the future of flying-boats seemed so black. The majestic Short Solents are in retirement after brief and profitless service on the African run, and for the first time since the old Calcutta biplanes flew out along the Empire routes our maritime nation is without its universally admired fleet of merchant flying-boats—inheritors of the tradition founded by the East Indiamen, the Blackwall frigates, and the clipper ships.

Truly, this is a dismal situation; but it was economically inevitable and—more's the pity—is no longer brightened by the prospect of the great Saro Princesses acceding to their place in world commerce. It would appear, in fact, that unless the projected pure-jet Duchess is adopted by some airline able to exploit its particular qualities, construction of large commercial flying-boats in this country will cease for years to come.

But we may be sure that the world has not heard the last of British flying-boats. Though the future of the Solents is as yet undecided, answers to Parliamentary questions tend to confirm that the ten-engined, 140-ton Princesses are destined for service with R.A.F. Transport Command. Had these great machines been planned with troop- and freight-transport in mind they might have been appreciably different, especially in hull design; but bearing in mind the record of the smaller Martin Mars, long-established in U.S. Naval service, a useful and honourable career can be foreseen for the three Princesses now on the stocks. It is, perhaps, not without significance that the new American Convair XP5Y-1 flying-boat, with four double turboprops, will see service not in its intended role of patrol and anti-submarine aircraft, but as a naval trooper/freighter for trans-oceanic service.

Aside from transport, the military applications of the large flying-boat remain as anti-submarine warfare, general reconnaissance, patrol and shadowing for protracted periods, and air/sea rescue. The technical merits of the flying-boat designed for these duties, *vis-à-vis* a corresponding landplane, are matters of perennial dispute. It would appear, in fact, that in the anti-submarine role the boat may be at a disadvantage in being less amenable to the installation of bulky search-radar and large quantities of anti-submarine weapons.

Service Needs

There is one fact, however, which no technical advance has yet altered: in certain strategically important parts of the world large landplanes are rendered quite impotent by natural obstacles. In his recent R.U.S.I. lecture A.V-M. Mackworth, S.A.S.O., Coastal Command, pointed out that excellent flying-boat bases exist (particularly in the Indian Ocean and the Pacific) where construction of airfields would be slow, costly, difficult or impracticable. To meet the needs of different areas the Air Vice-Marshal believes that the bulk of our general-reconnaissance aircraft should be landplanes along, with a number of flying-boat squadrons mainly located overseas. He envisages specially equipped depot ships, augmenting the efficiency of advanced bases, in the manner of Naval dockyards. With these opinions we are firmly in accord.

For their immediate implementation we have Avro Shackleton landplanes and the Short Sunderland flying-boats. The Shackleton is a new machine, only now entering service, and capable of lengthy development; but the Sunderland is the oldest type of operational aircraft in the R.A.F., and has been developed to the utmost. It may be that the Solents, which are closely related to the military Seaford (a Hercules-powered Sunderland development) might be pillaged of their luxurious appointments and usefully converted to augment the ageing Sunderlands; nevertheless, a replacement, embodying the latest techniques in aerodynamic and hydrodynamic design, and powered with turboprop or compounded power plants, is, to our mind, overdue. Not only would such craft play a vital part in Commonwealth defence, but they would sustain those constructors whose faith in flying-boats for military and civil purposes remains—like our own—unshaken, and whose dreams of "argosies with magic sails" may yet be realized.

HILLER HORNET

A Diminutive Two-Seater Ramjet Helicopter : Low Operating and Initial Costs : Military Possibilities

Two of the three Hornets now flying. One is seen in skeleton form, the other complete with plastic skinning and Plexiglas Cabin enclosure.

SINCE 1948, when he succeeded in marketing a reliable and economical light helicopter—the Model 360—Mr. Stanley Hiller has been recognized as a brilliant young designer (he is a 26-year-old Californian) who has something to show to many of the old hands. He has now announced successful flights with a new design named the Hornet. It is a small two-seater with ramjet (athodyd) propulsion at the blade-tips.

It seems that investigation of the costs of the Hiller 360 indicated that the most expensive units were the transmission, gearing and clutch, and, of course, the engine itself. A way of eliminating them all was to employ ramjets; many possible designs were therefore studied and eventually a type was developed which could do the job for a consumption of 41 gall/hr for the two units—one on each blade-tip.

Research continues, and later units give hope of eventually halving this consumption figure. The existing ramjets are simple and light and require virtually no servicing. They are not particular as to the type of liquid fuel fed to them, though kerosene or high-octane petrol give the best results.

In order to light up it is necessary to accelerate the rotors to a minimum of 150 r.p.m., and three alternative design-arrangements have been devised for the purpose. The rotor may be hand-cranked, or turned by a portable electric motor with battery, or rotated by a small two-stroke petrol engine (described as of the motor-mower type but better explained, perhaps, as an "inboard outboard") built into the aircraft.

Replaceable in three minutes, and provisionally priced at 200 dollars, the Hornet's tiny ramjets weigh 11 lb and produce 30-lb thrust.

When the rotor has attained 150 r.p.m., fuel pressure is built up with the aid of a wobble pump in the cockpit and the fuel-flow valves are then opened. On the starter button being pressed the jets fire, and the r.p.m. start to build-up rapidly. The starting procedure takes about 1½ min and operational rotor speed is 500 r.p.m. Presumably centrifugal force produces the requisite fuel-feed pressure once the blades are turning under power.

The ramjets, which have no moving parts, are constructed from heat-resisting steel, and they are attached to the blade-tips by two bolts and a steel support. Replacement of a unit is said to take only 3 min. The equivalent power of the two ramjets is 70 h.p., or in terms of thrust they produce 30 lb each. Highest operating temperatures are in the region of 3,000 deg F., and the life of the present units is given as 500 hours. At the operational rotor speed of 500 r.p.m. the tip speed is approximately 450 m.p.h.

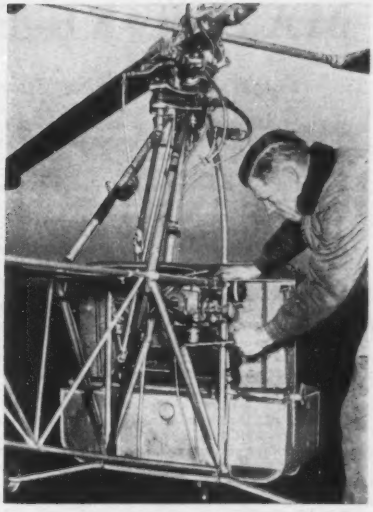
As more efficient ramjets are developed it will be a very simple matter to replace the earlier type on the machine. With only limited production in mind, a price of 200 dollars per unit has been mentioned, but in the event of large-scale production being ordered a much lower price could be expected.

By comparison with the weight of a piston engine to produce the same power, the weight of the ramjets—11 lb each—is remarkable. It is, in fact, the reduction in weight of power unit and transmission which has enabled the empty weight of the Hornet to be kept to little more than a third of the all-up weight of 900 lb.

Incidental advantages claimed for the Hornet's ramjet power source are best listed as negatives: no carburettor to ice up; no ignition system to fail or require maintenance; no radio interference; no warming-up delays; and practically no general maintenance.

Regarding noise, it is understood that in flight the level compares with that of the Model 360's 200 h.p. piston-engine, but that when the machine is hovering it is somewhat louder.

Turning to the Hornet's controls and airframe, like the earlier 360 it has an overhead cyclic-control stick and rotor-matic controls. This stick governs the direction of flight. Another manual lever looks after collective pitch and incorporates a power control—in this case a fuel-flow valve. This



Above : A comparison of sizes is afforded in this view of the Hiller 360 and the Hiller Hornet. Simplicity is the keynote of both designs. Right : A small built-in two-stroke starter is one of three alternative methods for spinning the rotors prior to lighting-up.

one is concerned with "up and down" flight or, if moved from side to side, operates the rudder to control the heading of the aircraft. These are the only two controls.

The rotor blades comprise a solid extruded aluminium alloy leading-edge and a built-up trailing portion of magnesium alloy.

The fuselage of the Hornet could scarcely be simpler. It consists of a two-seat enclosed cabin and a tail boom, both constructed from tubular steel and covered with plastic material. The front of the cabin comprises two very large Plexiglas panels and their frames. In addition to the control levers the cabin contains a wobble pump, a starting button, a fuel-flow gauge, a rotor r.p.m. indicator, an A.S.I. and an altimeter.

It is learned from C.B. Helicopter Hire, Ltd. (of School Lane, Chearsley, Aylesbury, Bucks), United Kingdom joint representatives for Hiller Helicopters, Inc., that plans were in hand to market the Hornet commercially in large numbers, beginning this spring, and that a target price of 4,900 dollars had been in mind. The present international situation, however, has dictated that the resources of the Hiller factory be devoted entirely to Service production of the type 360. The first order for a trainer version of this aircraft was placed by the U.S. Navy, but a later Army order for ambulance 360s was given priority in view of the urgent requirement in Korea. In addition, a U.S. Navy contract has been awarded to Hillers for the development of jet rotor designs (*Flight*, January 11th). The initial batch of 12 Hornets—three of which are flying, while the components of the remainder have been completed—may therefore be the only one for the time being. An extensive test and development programme is in mind for them. There is little doubt that with a price of about £1,000, controls (two only) which are easy to handle, and an aircraft which is inherently stable, the Hiller Hornet approaches nearer than any other to the conception of an "everyman" helicopter.

Should military authorities see a future for these remarkable little machines—as seems possible—and place a sizeable order for them, they might ultimately become available for much the same price as a light car. It is by no means fantastic to foresee helicopter despatch-riders with machines rugged and simple enough to be maintained in an M.T. section.

From the civil point of view, where the cost of the helicopter has so far been a major snag, not only is the price provisionally proposed for the Hornet well within the means of thousands of private owners, but running costs, and in particular maintenance and repair (and therefore, no doubt, insurance too) may possibly be kept lower than those of a two-seater fixed-wing aircraft.

HILLER HORNET

Dimensions and Performance

Fuselage length	12ft 8in
Track	5ft
Height	6ft 8in
Rotor diameter	23ft
Empty weight	340 lb
Disposable load	560 lb
Gross weight	900 lb
Maximum speed	85 m.p.h.
Cruising speed	70 m.p.h.
Climb	1,200ft/min
Estimated ceiling	12,000ft
Range (30 Imp. gall)	50 miles
Endurance (30 Imp. gall)	40 min

THE DEBATE ON DEFENCE

LITTLE concrete air-news emerged from the debate on the defence programme in the House of Commons on February 14th. Mr. Shinwell, Minister of Defence, said that provision for the R.A.F. would again be nearly doubled. Re-equipment of fighter squadrons with jet aircraft had nearly been completed, and deliveries of the Venom would begin this year. Other new aircraft which represented a "really big advance" on present types were not far off and had been ordered in large numbers. The possibility of acquiring American F-86s—the fastest fighters actually in production to-day—was being explored. Canberra squadrons would begin to form shortly; it was expected that the type would be adopted by a number of Allied countries. An important advance was the placing of the first production order for a four-jet bomber to replace the piston-engined Washington.

Several new squadrons had already been formed in Germany, and there would be a much larger number. The night-fighter force would be greatly increased with new jet machines, now coming forward. The size of Coastal Command was being increased, and the run-down of Transport Command had been stopped. "Certain new squadrons" had already been formed in the Middle East as the beginning of a considerable increase in strength in that theatre. We had embarked on much the most exacting expansion programme for the R.A.F. ever initiated in peace. In 1951 we should get a useful accession to our strength, and in 1952 things would "begin to happen on a big scale."

Though the supply of scientific and technical staff had considerably improved during the past two years, as the universities produced graduates who entered immediately after the war, the demand kept ahead of supply, and it could not be said that the position was much easier.

MAJOR RE-EQUIPMENT BEGINS

£1,000 Million Defence Estimates: More Fighters and Anti-Submarine Aircraft

A TOTAL of £328,750,000 net is provided for in the Air Estimates* for 1951-52, announced last week. This figure, £105,750,000 more than for 1950-51, is based on the programme drawn up last summer and thus does not take into account the important measures recently made public. Supplementary estimates for about £300 million under the revised defence programme will be presented later on. Each of the Services expects to devote the major portion of the sum allocated to it to re-equipment.

The Navy's whole programme is largely directed towards "meeting the under-water menace of submarines and mines"; two-thirds of the Army estimates will be spent on rearmament and stores, including tanks and guns; while the Air Force plans a further large increase in both day and night fighters, and the provision for the first time of large numbers of jet bombers.

Broad details of the R.A.F.'s expansion programme are dealt with in the memorandum of Mr. Arthur Henderson, the Secretary of State for Air. It seems that the front-line strength of the R.A.F. increased considerably during the past year, particularly in Fighter Command and B.A.F.O., and that, as a result of more men and money becoming available, this may be regarded as a first step towards much more substantial increases to be achieved during the next two-year period.

Twice the number of regular day-fighter squadrons are now operating, as compared with late 1949, and the night-fighter force is to be greatly increased at once and equipped with jet fighters. In addition, a large number of squadrons of Canberras are to be formed, the first of which will be in operation this year. In this way the strength of the tactical bombing forces will be greatly increased. Bomber Command will, for the time being, continue to operate a medium-weight force of Washingtons and Lincolns until later types come into service. No further mention is made of new four-engined jet bombers, though previously it had been stated that such machines have already been ordered. Coastal Command is to be substantially strengthened and its Shackletons are now going into squadron service. Transport Command alone remains in the doldrums, but it is stated that the "run-down" has been halted.

A brief reference is made to Far East Air Force, to which jet fighters have now been flown for re-equipment of squadrons at Singapore.

In the Navy estimates, which, as already mentioned, are concerned in the main with anti-sumbarine measures, reference is made to a number of new ships, including two fleet carriers and four light carriers. It is also stated that the equipment of air groups with up-to-date aircraft, including jets, is being pushed on as rapidly as possible; this has entailed development of naval air stations at a cost estimated at £1 million. Of the £33,157,000 earmarked for "Naval stores, etc.," £10,537,000 is to be devoted to air stores.

On the subject of R.A.F. manpower, the total strength provided for is 270,000 as against the original figure of 215,000 for the 1950-51 period. A breakdown of expenditure also indicates that £24,150,000 extra will be found for pay, etc.; new married quarters in hand will cost £7,200,000.

Totals for 1951-52 (and the increases over the previous year's estimates) under various main headings are tabulated below.

ABSTRACT OF ESTIMATES

Service	Net Estimate	Increase
	£	£
Pay, etc.	77,000,000	24,150,000
Aircraft	81,000,000	26,220,000
Armament and explosive stores ...	17,600,000	10,850,000
Radio, radar and electrical	12,300,000	3,135,000
Instruments and photographic... ...	5,870,000	640,000
Vehicles and marine craft	10,900,000	5,500,000
Reserves and Auxiliaries	1,569,900	127,000
Civilians at outstations	22,390,000	3,238,000
Works and lands	37,500,000	11,060,000

One of the few decreases is found under the heading of Meteorological Equipment, reduced by £35,000 to £250,000. A significant increase, however, may be noted under the heading "Armament and Explosive Stores," which amounts to £17,600,000 —an increase of £10,850,000 over the 1950-51 Estimates.

Analysis of the above totals indicates that of the figure for aircraft some £35.6 million goes for airframes, £23.5 million for engines, and £22 million for spares and accessories. Armament accounts for only £4 million of the combined total under the heading, and radio and radar costs are £7.6 million.

Air Estimates, 1951-52, price 5s., Navy Estimates, 1951-52, price 6s. His Majesty's Stationery Office.

Smiths Acquire Waymouth

IT is announced that Smiths Aircraft Instruments, Ltd., who have hitherto held the sales rights for the "Smiths Waymouth" electrostatic fuel contents gauging system, have acquired the entire share capital of the Waymouth Gauges and Instruments, Ltd., whose offices and works are at Godalming, Surrey.

Research, design, development and production of the gauge and other products, including Waymouth relays, will continue under the technical direction of Mr. E. B. Moss, chief engineer of the Smiths group of companies.

Directors of the Waymouth Company are now Mr. Ralph Gordon-Smith; Mr. Leonard Morgan, A.F.R.Ae.S.; Mr. E. B. Moss, B.Sc., F.Inst.P., A.F.R.Ae.S., M.I.A.E.; W/C. H. M. Samuelson, R.A.F.O., A.M.I.E.E.; Mr. H. Waymouth, B.E., A.M.Inst.C.E.

Sales will be handled by Smiths Aircraft Instruments, Ltd., of Cricklewood, London, N.W.2.

AUSTER FLOTATION: Seen here at Beaumaris, Anglesey, is the Auster J-5 floatplane conversion which, in addition to offering increased versatility, is in some ways even more pleasing in appearance than is its landplane counterpart. The modification is to be marketed in conversion-kit form. Similar conversions of the military Auster Mk 6 were used on an Antarctic expedition last year.

("Flight" photograph)

FROM ALL QUARTERS

Sir Allan Gordon-Smith

THE British aviation industry has suffered a great loss by the death, which occurred last week, of Sir Allan Gordon-Smith, K.B.E., D.L., chairman of Smiths Aircraft Instruments, Ltd. He had also been chairman of the parent company, S. Smith and Sons (England), Ltd., since 1945, and its managing director for 31 years before that.

It was Sir Allan's initiative that led the firm to venture outside the field of watchmaking and manufacturing early car instruments and thus to supplying many of the first aircraft instruments used during the 1914-18 war. Shortly before the Second World War he again showed his foresight, this time by establishing the vast Cheltenham factory entirely devoted, then as now, to the production of aircraft instruments and allied equipment.

In 1940, at the request of Lord Beaverbrook, Sir Allan Gordon-Smith went to M.A.P. as Controller of Emergency Services, a post which he held until the end of the war.

Sir Allan leaves a widow, a son (who is managing director of the parent company) and three daughters.

Prestwick Proposals Approved

ON February 15th the Minister of Civil Aviation, Lord Pakenham, stated in the House of Lords that he had accepted certain proposals made by a committee of the Scottish Council, which, under the chairmanship of Lord Clydesmuir, had investigated and reported on the possibilities for the future development of Prestwick airport. Among the proposals was one that the main runway should be extended westward by 400ft and the existing wall between the runway and the main Ayr-Kilmarnock road pulled down. This would give a usable runway length of 7,000ft. The road itself would be diverted to allow a 1,000-ft over-run with 500ft to spare. An undulation on the main runway would also be removed.

No financial obstacle, said Lord Pakenham, would be allowed to stand in the way of completing these improvements as soon as possible. B.O.A.C. tests had shown that a usable runway length of about 7,000ft was enough to enable the main runway to be used on 85 per cent of Stratocruiser take-offs at full load (i.e., 145,800 lb). The report had rejected the suggestion that a flying-boat base should be included as an integral part of the airport.

Lord Pakenham also paid tribute to what he termed the "conspicuous fairness" of the Clydesmuir Report, compilation of which had been a particularly difficult task in view of the fact that the subject was so heavily over-loaded with past controversy.

Brough R.Ae.S. Lecture

AT the February meeting of the Brough Branch of the R.Ae.S., A/Cdre. F. R. Banks, C.B., O.B.E., F.R.Ae.S., M.I.Mech.E., delivered a lecture, on "Aircraft Engines," which provided plenty of interest for the 150-odd members who formed the audience. He is, of course, well qualified to speak on the subject, for he is technical manager and chief engineer of the Associated Ethyl Co., and during the war was Director-General of Engine Production at M.A.P. and then Director-General of Engine Research and Development.

A/Cdre. Banks discussed the historical backgrounds that eventually led up to the eclipse of the piston engine by the gas turbine, explained the arguments in the "centrifugal *versus* axial" controversy, and *inter alia*, gave his views on power-unit development in relation to supersonic aircraft. He quoted some striking figures —such as the 170 tons of air which a gas turbine of 7,000 lb thrust consumed in an hour's running at full power.

Major G. P. Bulman, C.B.E., B.Sc., F.R.Ae.S., president of the R.Ae.S., was present at the meeting. Introduced by Mr. G. E. Petty, F.R.Ae.S., chairman of the branch, Major Bulman referred to the importance of the work of the branches, whose 7,500 members were situated all over the British Isles.

He complemented Brough on winning the Society's Branch Prize on two of the five occasions on which it had been awarded.

Mond Nickel Fellowships

TO encourage aspirants to achieve advancement in the metallurgical and metal-using industries, the Mond Nickel Fellowships Committee is inviting applications for five 1951 Fellowships to an average value of £750 each. Application forms, which must be returned by June 1st, are obtainable from the Secretary of the Committee, at 4, Grosvenor Gardens, London, S.W.1. Only in exceptional cases will applicants over 35 years of age be considered.

B.O.A.C.'s Flight Simulator

NEARING completion at the Wandsworth works of Redifon, Ltd., is the first British flight simulator, built to the order of B.O.A.C. The aircraft represented is the Stratocruiser as operated by the Corporation's North Atlantic Division, and this first equipment closely resembles the Curtiss-Wright (Dehmel) simulator installed at La Guardia Airport by Pan American Airways and described in our issue dated December 8th, 1949.

Following an arrangement made with the Curtiss-Wright organization allowing exchange of technical and other information (*Flight*, October 24th, 1949), Redifon have been working on the B.O.A.C. Stratocruiser simulator for about fifteen months. The first three months were taken up while a team studied the construction of the American product; next, alterations were made to suit B.O.A.C.'s special requirements and, as it is a later design, certain improvements and additions have been made in the original plans.

When we visited the Redifon works last week the stage had been reached when tests and calibrations of the units were being carried out, and it was learned that in four to six weeks' time, the simulator will be transported in parts to its site at Meadowbank House, B.O.A.C.'s training section near London Airport. It is estimated that the Corporation will save many thousands of pounds a year in the cost of crew training and periodic checks. Further reference will be made to this in a forthcoming issue.

Close to the shop in which the first simulator has been built may be seen the shell of a new building which is to house a Comet simulator, also on order for B.O.A.C. crew training.

New Hawker Director

Mr. E. H. JEFFERSON has been appointed a director of Hawker Aircraft, Ltd., after 30 years' service with the company. In 1922 he was their only inspector; by 1938 he was chief of a large inspection department. In 1947 he became quality controller, a post he will continue to hold in his new capacity.

The Grounded Vikings

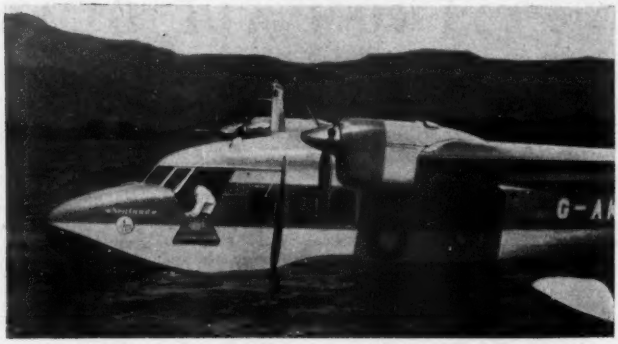
FOLLOWING the recent temporary grounding of 19 B.E.A. Vikings as a result of a defect being discovered in an airscrew-hub barrel during a periodic strip-inspection (as reported in *Flight* of February 1st), Rotol, Ltd., the makers of the airscrews, have issued an informative statement.

The nature of the defect, they state, consisted in fissures occurring at the root of the thread bore in the mouth of the hub socket (this particular thread carries the blade mounting). The fissures became apparent only on a certain number of hubs which had been in service operation for periods of 3,500 to 4,000 hours, a proportion of hubs having given satisfactory service up to 4,000 hours. The fissures are due to fatigue effects in the hub material which only come to light after very long periods of service operation and are invariably concentrated at a point where a sudden change in section occurs in the hub structure. For this reason, it is stated, great care has always been taken in the production of these threads and other allied features in the blade mounting, together with a systematic and close inspection at the present overhaul period of 1,280 hours.

In the light of recent developments it has been shown that the fatigue life of the hub can be considerably lengthened by certain improvements in the thread production and blade-mounting technique. Certain of these improvements are being incorporated immediately, but until it is possible to embody all of them it has been agreed with B.E.A. and the A.R.B. to fix a safety-life of 3,200 hours on the hub barrels.

The makers point out that only exceptionally long periods of service operation would show up the defects in question, and it was not until airscrews had been operating on the post-war commercial airlines that such experience became available.

HERE AND THERE



AMPHIBIOUS MISSION: This Short Sealand, pictured on a Venezuelan lake, is acting as a herald for the Festival of Britain during the extensive demonstration tour now in progress. The performance of this neat amphibian has already interested several operators in North and South America.

Balliols by Blackburn

THE Ministry of Supply has placed a substantial production order with Blackburn and General Aircraft, Ltd., for Boulton Paul Balliol 2 trainers. The Balliol (Rolls-Royce Merlin 35) is already being produced by Boulton Paul as the standard advanced trainer of the R.A.F.; the new contract will speed-up delivery.

Czech Complaints Refuted

RECENT complaints by Czechoslovakia that American aircraft had violated the border between Czechoslovakia and Western Germany and carried out espionage have been dismissed by the United States as fabrications. All American pilots, it is stated, have instructions not to cross the Czech border—and, in the case of fast aircraft, not to fly within 10 miles of it.

Anglo-U.S. Conference Date

THE R.Ae.S.-I.A.E. Third Anglo-American Conference at Brighton, previously announced for September 6th-11th, has now been put forward to September 3rd-7th. It will thus end a few days before the S.B.A.C. Farnborough Show (September 11th-16th) instead of immediately preceding it.

F-80 Record

FROM the outbreak of the Korean war to the end of January, Lockheed F-80 Shooting Stars flew 26,356 sorties—over half the total flown by fighters—and destroyed 94 enemy aircraft. On ground-attack work, they dropped 1,662 tons of bombs and fired 49,873 rockets and 19,810,852 rounds of 0.50in ammunition.

The number of F-80s engaged has not been stated, although nearly 400 were stationed in the Far East when war began. During the period mentioned, 65 F-80s were lost—less than half of them by enemy action. Only four were shot down by Communist aircraft. An F-80 was responsible for destroying the first Mig-15.

In combat, the F-80 has shown the ability to sustain a great deal of battle-damage. This quality is the subject of a masterly understatement in a recent Lockheed press-release: "Of prime importance to the pilot, the F-80s come home."

Belgian-built Meteors

QUICKER delivery of Gloster Meteor 8s to the Belgian Air Force will result from the setting up of a production line at the Gosselies works of Avion Fairey in Belgium. A contract for licensed production of the Meteor 8 was signed in London last week by Mr. P. G. Crabbe, general manager of Gloster's, and M. E. O. Tips, Fairey's Belgian manager.

Formerly, the Belgian Air Force was to have received its Meteor 8s from the Dutch Fokker works, which can now concentrate on deliveries to the Netherlands Air Force. Rolls-Royce Derwent 5 turbojets for Dutch and Belgian Meteors are built in Belgium by the Fabrique Nationale.

Sapphire-Thunderjet Flies

AN experimental version of the swept-wing Republic F-84F Thunderjet, powered by an Armstrong-Siddeley Sapphire turbojet, made its first flight at Muroc on February 15th. The results of the test, which lasted an hour, were described as satisfactory.

Installation of a Sapphire (7,200 lb thrust) has increased the performance of this latest type of Thunderjet in almost every respect—take-off, climb and level speed. The Curtiss-Wright Corporation has acquired a licence to produce Sapphires in the United States, and this company's output is to be supplemented by the Buick Division of the General Motors Corporation. American designation of the Sapphire is J-65.

Lecture-date Changed

THE Helicopter Association announces that the lecture of *Convertible Aircraft* which was to have been delivered by Capt. R. N. Liptrot, C.B.E., B.A., on March 24th has been put forward to Saturday, March 17th. It will be given at the Royal Aeronautical Society, 4, Hamilton Place, London, W.1.

To-night at the R.Ae.S.

THIS evening, February 23rd, at the Institution of Civil Engineers, the Fourth Louis Bleriot Lecture is to be delivered before the Royal Aeronautical Society by M. Maurice Roy, Director of the French *Office National d'Études et des Récherches Aéronautiques*. His subject is *Power versus Weight in Aviation*, and the first section of the paper will be devoted to detailed comparisons of these two factors from the very earliest days of heavier-than-air flight. In the second part, which is of a fairly advanced nature, the lecturer will show the effects of modern design-tendencies, with particular reference to turbojet and turboprop power. M. Roy will, it is believed, read his paper in French, but an English translation has been printed by the R.Ae.S. It is worthy of note that M. Roy makes the claim that a Frenchman, Ader, flew a powered heavier-than-air machine in 1897—six years before the Wright Brothers.

Three Test-beds

COUNTERPARTS to the Lancaster and Lincoln test-beds used for research in Britain, three Boeing bombers are being employed by Pratt and Whitney for flight-testing of three new gas turbines. The oldest of the trio is a B-17 Fortress bought by P. and W. from an Oklahoma scrap-heap; this carries the 6,000-h.p. T-34 turboprop in its nose and can fly with all four piston engines stopped.

Pratt and Whitney's version of the Tay, the J-48, is being flown beneath the bomb-bay of a B-29 Superfortress lent by the U.S. Navy. Afterburning has been successfully developed for the J-48, and its "dry" thrust rating of 6,250 lb can be

LATENT HEAT: A Lockheed F-80C in Korea is seen with a formidable war-load of six napalm bombs—110-gallon tanks of jellied petrol. These missiles, dropped at low level, have a devastating effect on tanks, troops or transport. Some statistics on operations by F-80s in Korea are given in a paragraph ("F-80 Record") above.

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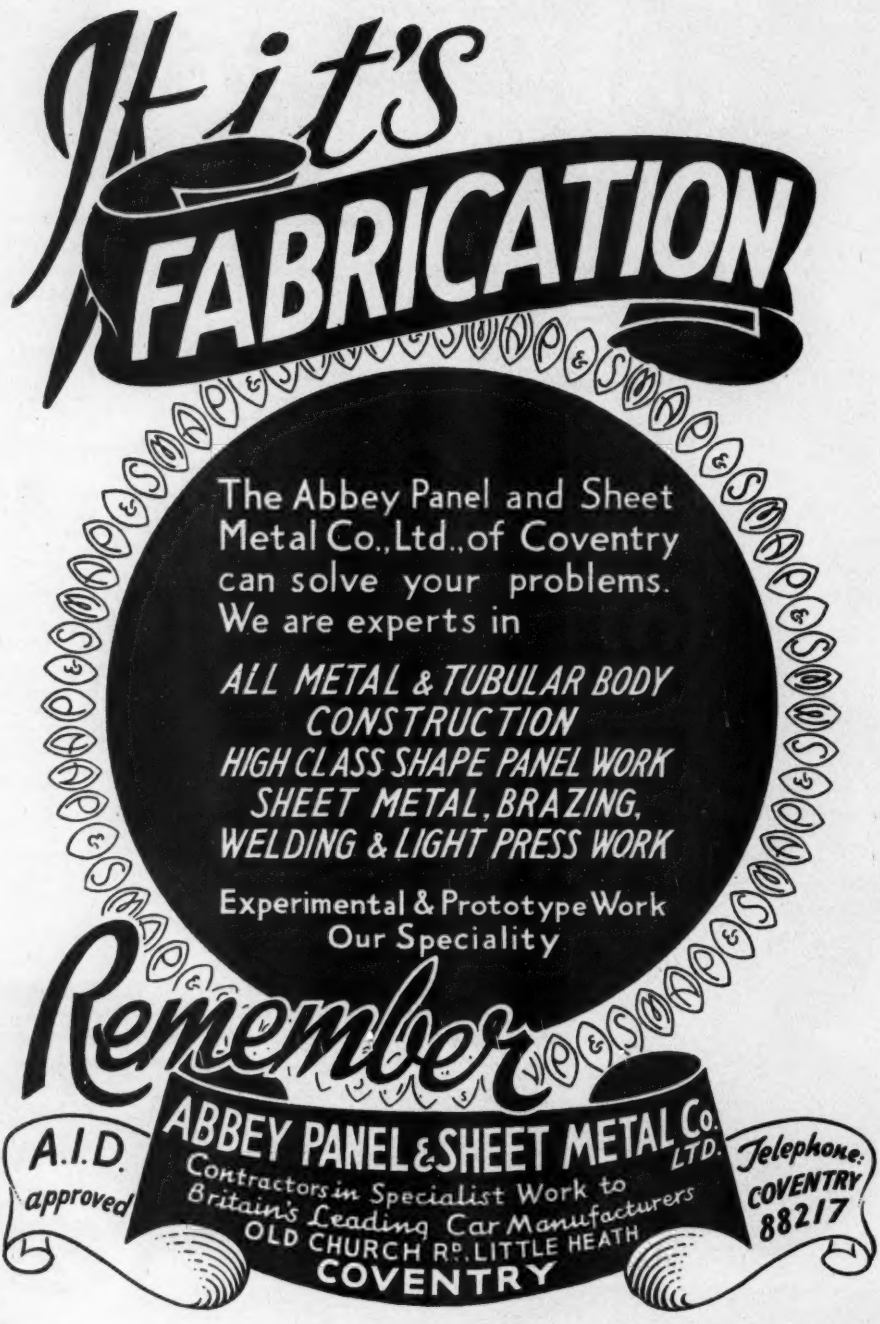
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HERE AND THERE...

further increased by water injection. Third of the Boeing test-beds is a B-50, lately acquired from the U.S.A.F. and fitted with a "pod" beneath the fuselage for a new P. and W. turbojet, as yet undesignated.

Still Going Strong

ONLY one type of piston-engined fighter is now being produced in the United States—the Chance-Vought F4U-5 Corsair (2,400 h.p. P. and W. Double Wasp). The service history of the Corsair began in 1940, when Vought-Sikorsky delivered the first prototype to the U.S. Navy. Orders were placed in 1941, and 10,000 Corsairs had been built by mid-1945. The latest examples, which fly at over 450 m.p.h., are armed with four 20 mm guns and carry bomb-loads of up to 3,200 lb, are to-day performing valiantly over Korea.

Deck-landing Delta

PRELIMINARY details have been released of the second American delta-wing aircraft to fly—the Douglas XF4D naval intercepter (illustrated in *Flight* of February 8th). The first flight—"30 minutes at altitude"—was made on January 23rd at Muroc. Designed specifically for interception, the XF4D is equipped for catapult take-off from carriers; its power plant is probably a single axial-flow turbojet—reported to be the new Westinghouse J-40, which is claimed to produce 10,000 lb thrust with afterburning. No tailplane is fitted, and the fin is of high-aspect-ratio, swept-back design. The tips of the delta wing are rounded and the leading-edge roots—or "apex"—are enlarged and faired forward to form air-intakes.

Russian Air Strength

THE Chief of Staff, U.S.A.F., General Vandenberg, stated last week that Russia had at least 450 bombers capable of reaching the United States from Soviet bases. The best Soviet bomber, he said, was the Tu-4 (Superfortress), but Russia was working on an aircraft to match the B-36, and would unquestionably build it.

He estimated that 70 out of 100 Russian bombers making a determined attack on the U.S.A. would reach their targets. To shoot down 30 per cent of an attacking fleet, America required an air-defence system three times more effective than that of Britain in the last war, although the area to be protected was 30 times as large. In more cheerful vein, General Vandenberg declared that only a few aircraft would carry atom bombs; even if Russia had 100 atom bombs—which she had not at present—she could not afford to use them all in one raid.

TANK THANKED: President Peron (right) congratulates Professor Kurt Tank, designer and test-pilot of the Pulqui II jet fighter, after a recent demonstration at Buenos Aires. News of the aircraft and its designer is given below.

Man of Parts

PROFESSOR KURT TANK, now employed by the Instituto Aerotechnico of Argentina, has supervised the design, construction and now test-flying of that nation's second jet fighter—the Nene-powered I.Ae-33 Pulqui II (Arrow). This advanced jet fighter has an estimated top speed of 646 m.p.h.; its shoulder-position wings are swept back 45 deg, and the tail surfaces—of T-form layout—have 50 deg of sweep-back. The Rolls-Royce Nene 2 turbojet is fed by a nose air-intake.

Professor Tank, as technical director of the German Focke Wulf concern, was responsible for many successful designs, including the famous Fw 190 fighter. He made the first flight of the Fw 200 Condor, and it was his practice to fly as many of his own designs as possible. After the war, he related with satisfaction that superior speed had enabled him to avoid the attentions of five Mustangs during a test-flight with the Ta 152, a development of the "190."

NEWS IN BRIEF

THE journal *British Engineering*, sale of which was previously restricted to overseas circulation, is now available in this country. It is obtainable on the first Wednesday of each month, price 2s 6d, from newsagents or direct from Associated Iliffe Press, Dorset House, Stamford Street, London, S.E.1.

* * *

In pursuance of its policy of sharing "know-how," the Glenn L. Martin Co., Baltimore, has reprinted 17 articles from *The Martin Star* in the form of a 40-page booklet entitled *Modern Techniques in Aircraft Manufacturing*.

During 1950, Britain exported 20,778 tyres (valued at nearly £300,000) for aircraft; in addition, exported British aircraft carried a further 2,556 tyres. Corresponding figures for 1949 were, respectively, 18,874 and 3,744.

* * *

Claimed to be the most powerful valve-driven H.F. induction-heating generator in Europe, new equipment built by Philips Electrical, Ltd., has recently been installed by de Havilland Propellers, Ltd., for hardening duties. It has maximum outputs of 150 kW (continuous) and 200 kW (intermittent).

* * *

A leaflet from the Acru Tool Manufacturing Co., Ltd., 123, Hyde Road, Ardwick, Manchester, 12, illustrates a set of ingenious "finger tools" to facilitate assembly of small parts in awkward positions. Spring clips to fit over the operator's fingers are surmounted by compact nut sockets (sizes 0, 2, 4 and 6 B.A.), tweezers, screwdriver-blades and similar small tools.

* * *

A page of a catalogue of "RMB" miniature ball-bearings is devoted to their application in artificial horizons, gyro-pilots, turn-and-bank indicators and other aircraft instruments. Manufactured in Switzerland, these bearings are now made available in Great Britain by Miniature Bearings, Ltd., 192, Sloane Street, London, S.W.1. A sample bearing enclosed with the catalogue, though consisting of cup, dust cover, cage and three chrome steel balls, is of only 1.1 mm overall diameter—little larger than a pin's head.

SIZE IS RELATIVE: The largest refueller at London Airport—an Esso tanker of 4,000-gallon capacity—was used to replenish the tanks of a U.S.A.F. C-124 when one of these big Douglas transports landed there recently. The vehicle was dwarfed by the 80-ton, 48ft-high aircraft.

FLIGHT RESEARCH

Mr. Handel Davies's R.Ae.S. Lecture: Part 1: Drag Analysis: Achievement of Laminar Flow

REFERENCE was made last week to a lecture read before the Coventry branch of the Royal Aeronautical Society by Mr. Handel Davies, M.Sc., F.R.Ae.S., A.F.I.Ae.S., principal scientific officer in charge of high-speed flight research at the Royal Aircraft Establishment. The purpose of his lecture was to illustrate the contribution which flight research can make towards the advancement of knowledge of aeronautics and, to reduce the wide field covered by his title, *Some Aspects of Flight Research*, Mr. Davies took typical examples under three main headings. The first of these, "Work Concerned Directly with Reducing the Drag of Aircraft", which formed the subject of the opening section of his paper, is summarized in the following pages.

The lecturer remarked that one of the main contributions which flight research could make towards improving the performance of aircraft was to measure the speed and drag of aircraft in flight, to analyse the sources of this drag, and to explore methods of reducing it. He thought that one of the best examples of this aspect of the subject was provided by the work done at the R.A.E. in recent years to investigate boundary-layer effects, and in particular to determine the conditions under which extensive areas of laminar flow could be achieved in flight.

In introduction, it was also pointed out that the drag of an all-wing aircraft was approximately halved if the transition from laminar to turbulent boundary layer moved back from the leading edge to about 50 per cent of the chord. The first step in achieving such a far-back transition was to design the wing so that the pressure gradient remained negative as far back as possible and over a reasonable speed-range. If the complication of boundary-layer suction was accepted, a favourable pressure gradient could be retained over practically the whole wing surface without ruining the wing characteristics from other points of view.

"Unfortunately, the maintenance of a favourable pressure gradient is very far from providing a guarantee of laminar flow, since an early transition can easily be caused by small irregularities," said Mr. Davies. There were two categories of irregularities: those inherent in the construction, such as skin waviness, overlap in skin joints, or roughness in surface finish; and those arising from contamination of the wing surface by dirt, insects and similar matter.

The effect of surface irregularities on the transition position [continued the lecturer], depends on the Reynolds number at transition and on the magnitude of the pressure gradient. The tests which have been made in flight have not been sufficiently systematic or comprehensive to separate out these effects completely, but enough has been done to give a reasonable indication of the standards which must be aimed at, and to provide some check on the systematic work of others.

In most of these flight tests the extent of the laminar boundary layer has been determined by one of the chemical methods developed mainly by W. E. Gray with the assistance of members of the Chemistry Department at the R.A.E. The first of these methods to be used in flight depended upon flying the aircraft through a trail of gas which reacted chemically with a thin liquid coating applied to the wing surface. The reaction in the region of turbulent flow was much more rapid than in the laminar boundary layer, and the discoloration produced gave a clear indication of the transition.

More recently two methods have been developed which dispense with the necessity for laying a trail of gas. One of these methods relies on the oxidising by the airflow of a solution of potassium iodide, starch, and sodium thiosulphate sprayed in a thin coating on the wing surface. The second method depends on evaporation or sublimation of a thin coating of a volatile chemical sprayed on the wing. Coatings of naphthalene, camphor, and fluorene have been used successfully for this purpose.

The extent of the laminar boundary layer has also been determined indirectly in flight by measuring the section profile drag coefficient, using a pitot comb mounted behind the test section, and the results in some cases compared with the chemical methods.

The most comprehensive flight tests on these lines have been on a Bell P-63 (King Cobra). This aircraft has a 66-series wing section, with a maximum thickness : chord ratio of 16 per cent located at 45 per cent of the chord, giving a peak suction at about 0.60*c* at $C_L = 0$. Thus laminar flow should be possible over at least half the wing surface.

In the form in which the aircraft was originally received at the R.A.E. (condition 1) it became clear that the transition was very close to the leading edge. Measurements of section profile-drag coefficient, using a pitot comb, gave a value of 0.008, which was equal to the estimated value of C_{DO} (drag coefficient at zero lift), for leading-edge transition. Removal of small local surface defects such as grit embedded in the paint, immediately reduced this drag coefficient to 0.005, at any rate for lift coefficients near 0.2, and this implied an average transition in the neighbourhood of 0.35*c*. Eventually, by improving the standard of surface waviness until the maximum variation on a waviness gauge with a 2-inch base was less than five-thousandths of an inch, the profile-drag coefficient was brought down to about 0.003 at $C_L = 0.2$. This implied a transition at about 0.65*c*.

These results are shown in detail in Figs. 1 and 2, and summarized in the accompanying table. The surface-waviness record corresponding to main condition 3 tested is shown in Fig. 3.

Condition	C_{DO} at $C_L = 0.2$	Estimated transition
(1) As received at R.A.E.	0.008	Near L.E.
(2) Slight improvements	0.005	0.35*c*
(3) Waviness reduced	0.003	0.65*c*

Experiments on a similar aircraft by W. E. Gray, using the chlorine method to observe the transition, broadly confirmed these conclusions, but were much more instructive in indicating the precise sources of early transition. They showed, in particular, the importance of a ridge at a skin joint, a 0.006in step down causing almost immediate transition. Eventually the surface condition was improved to such an extent that the remaining surface-waviness represented variations of less than two-thousandths of an inch measured on an Ames gauge with two-inch base, and irregularities at skin joints and rivets had been removed entirely (condition 4).

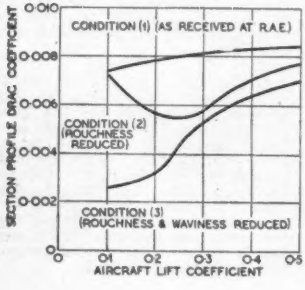


Fig. 1. (left). Effect of surface condition on section profile-drag for the King Cobra aircraft.

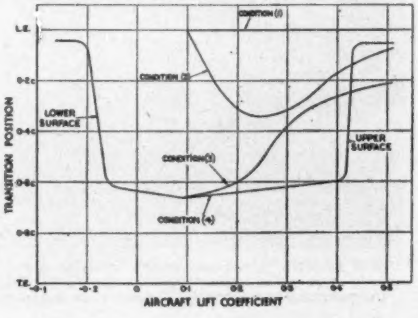


Fig. 2. (right). Effect of surface condition on transition position for the King Cobra aircraft.

Chemical observations of transition in this condition (extending incidentally to zero and slightly negative C_L) showed that this final improvement had very little effect on the transition position at lift coefficients near 0.2, but it did widen the range of C_L over which the transition can be kept back at 0.65*c*, to a maximum C_L of about 0.4, when the transition jumped abruptly forward.

This probably represents one of the best surface conditions ever achieved on an aircraft wing, and shows that at any rate at the Reynolds numbers of these tests (10-17 million, based on wing chord) laminar flow can be retained so long as the gradient does not become definitely unfavourable. In fact, in this case the transition was often behind the peak suction and also survived a small region of positive pressure gradient near the nose.

These results also illustrate the dependence of waviness requirements on pressure gradient. The forward movement of the transition in condition (3) at lift coefficients above 0.2 undoubtedly was due to the reduction in favourable g..dient with increasing C_L.

Similar tests have been made on a Hurricane, fitted with special low-drag wings manufactured by Armstrong Whitworth, Ltd.

These tests have shown that for Reynolds numbers of the order of 15 million, based on wing chord, it is necessary to reduce the waviness of the wing surface, as measured on a two-inch gauge, to something of the order of one-thousandth of an inch, if the transition is to be kept right back to the pressure peaks, over the

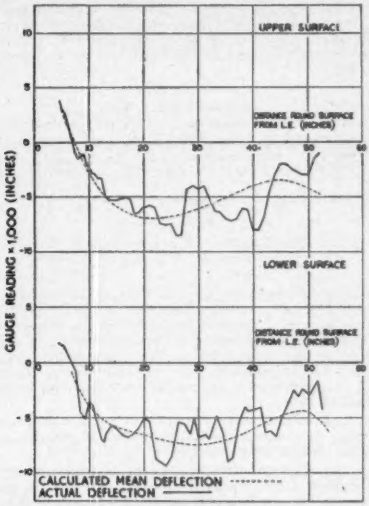


Fig. 3. Surface waviness of King Cobra wing with roughness and waviness reduced (condition 3).

full C_L range for which the wing has been designed. It represents a very severe demand on the manufacture and maintenance of wings, and few operational aircraft yet produced have come anywhere near to achieving this standard.

The attainment of full extent of laminar flow, theoretically possible over the entire design range of C_L, is extremely difficult in practice, especially at high Reynolds numbers; but it is not difficult to go quite a long way towards this ideal.

As a further illustration of this point, it is worth mentioning that a test made recently at the R.A.E. on a jet fighter which had not been specially treated, except for a very small amount of rubbing-down near the leading edge, gave a transition of 30-40 per cent of the chord over a large proportion of the wing surface, apart from a few wedges (see Fig. 4). In this case the skin joint was at the leading edge, and the waviness standard was extremely good for a production aircraft. On the other hand two other jet aircraft tested at the same time had a mean transition at about 0.10*c*, caused by poor rivets and skin joints.

Thus, although an enormous amount of effort is needed to achieve the full advantage theoretically possible over the design C_L range, a considerable gain can be achieved with very little trouble in construction and maintenance. How far even such a limited gain may be prejudiced by dirt and insect contamination will be discussed later.

Mr. Davies next spoke of boundary-layer research at high Reynolds numbers. The work described so far [he said] has been concerned with Reynolds numbers up to about 17 million. It has

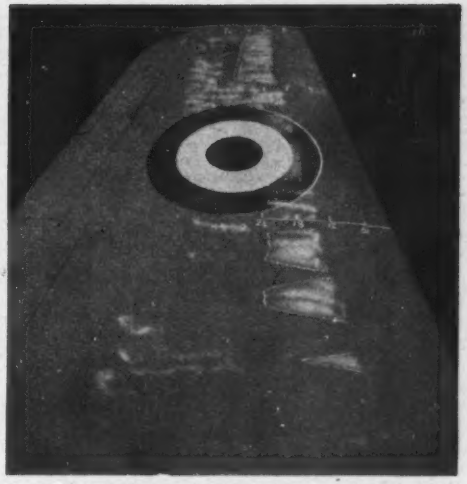


Fig. 4. Transition shown on the wing of a Vampire with standard finish but leading-edge waviness rubbed down. ($M=0.72$; $C_L=0.072$ $R=34\times10^6$.)

been seen that as the Reynolds number increases, the standard of surface waviness needed to ensure transition in the neighbourhood of the pressure peak becomes more severe.

It is important, therefore, to investigate the conditions under which a far-back transition can be achieved at the highest Reynolds numbers likely to be met in practice. The view has been put forward that there may be a definite upper limit—of the order of 16 million—to the Reynolds number at transition, even for a perfect wing. Existing experimental results appear to contradict this suggestion, and it is important to try to obtain a further experimental check on this point. Flight tests, therefore, are being made at the R.A.E. on the Armstrong Whitworth 52, observing transition by the evaporation method as the wing surface is progressively improved. If laminar flow can be maintained as far back as the pressure peaks on this wing, the Reynolds number at transition will be about 22 million, at the maximum speed.

High Mach Numbers

The lecturer then dealt with boundary-layer research at high Mach numbers. The possibility of maintaining laminar flow at high Mach numbers [he said] has not as yet received much attention. The problem does not seem to be fundamentally altered even when the Mach number is high enough for there to be extensive regions of supersonic flow and shock-waves present on the wing. A negative pressure-gradient is still favourable to the maintenance of laminar flow, the only difference being that as the Mach number increases the region of favourable gradient in general becomes more extensive, and in fact extends as far as the shock wave.

It is clearly important to investigate whether the standard of surface finish and waviness needed to ensure laminar flow back to the pressure peak under these conditions is the same as at low Mach numbers. Some preliminary work has been done on this problem at the R.A.E., using a de Havilland Vampire. The results suggest that the surface standards needed to achieve a given amount of laminar flow are much the same as at lower Mach numbers, for the same Reynolds numbers.

Earlier in his paper the lecturer had referred to contamination by insects. He now enlarged on this subject. So far it has been assumed [he said] that the wing has been thoroughly cleaned before take-off and that no contamination of the wing surface has subsequently taken place. Unfortunately, serious contamination of the wing often does occur, particularly from insects, and this constitutes one of the most difficult practical problems in making use of laminar-flow wings. Very minute insects or specks of dust are sufficient to initiate a wedge of turbulent flow and Fig. 5 illustrates the sort of thing which may happen.

The magnitude of the insect problem varies widely with geographical position, time of year, time of day, and weather conditions. During the winter months the number of insects picked up during one take-off in the Farnborough area is usually very small, especially in the mornings. In recent flight tests on the A.W.52

FLIGHT RESEARCH . . .

at the R.A.E., for example, the number of insects picked up per flight never exceeded one per 10ft span, and in most morning flights no insect contamination occurred at all. Rainy conditions and high winds also seem to tend to reduce the insect population.

In warmer weather the number of insects increases and on the afternoon of a warm summer day there have been occasions when so many insects have been picked up that the effective transition is brought near the leading edge over most of the wing surface. Even in mid-summer, however, the number of insects collected in an early morning take-off is usually small. Insect contamination also tends to become a more serious problem in warmer climates. During some systematic observations made in Louisiana in the U.S.A., for example, one insect was picked up per square foot of wing frontal area for every minute of a flight at 500ft.

Unfortunately, the mere possibility of a premature transition being caused by insects on some occasions is sufficient to prevent full use being made of laminar-flow wings in achieving long range. It should not, however, discourage efforts to achieve extensive areas of laminar flow as a means of attaining higher speeds under favourable conditions.

The area of wing which may be affected by insect contamination is not very large, extending perhaps from about 0.20c on the lower surface to about 0.07c on the upper surface. The possibility of protecting this surface during taxi-ing and take-off therefore arises, since the fly population decreases rapidly with increasing altitude.

During the R.A.E. experiments on the King Cobra, previously mentioned, some tests were made with a paper cover stretched over the front part of the test section and extending to about 0.3c on both surfaces. The paper was fastened to the wing round its edges and was ripped off after take-off by pulling a string passing from the cockpit round the paper at the leading edge. This method proved quite successful, but its application to the complete wing of a large aircraft obviously would be more difficult.

An attempt has also been made to coat the wing surface with a volatile solid material such as camphor, which would sublime away in flight, taking the insects with it. This method has not so far been successful.

Boundary-layer Suction

The lecturer next turned to boundary-layer suction. Although a large amount of theoretical and wind tunnel work has been done on boundary-layer suction [he continued] flight research on this subject has been limited so far, mainly owing to the complication and expense of the preparations needed for such a test. A few interesting experiments have been made in flight.

In order to investigate the practical problems involved in applying the now well-known principle of the Griffiths suction wing to an actual aircraft, the outer wings of a Meteor 3 were removed and replaced by special sections of the form illustrated diagrammatically in Fig. 6. These sections had a maximum thickness : chord ratio of 16 per cent and were designed to have a favourable pressure gradient almost to 0.75c, where there was a suction slot, nominally 0.04in deep, formed between the aileron and the wings as shown. The suction was provided by a modification of the blower normally used to cool the rear bearings on the Derwent 1 engines. This should theoretically have given values of suction coefficient C_Q at the slots estimated to be necessary to prevent a separation or rapid thickening of the boundary layer behind the slot, provided the boundary layer remained laminar to somewhere near the slot.

In the form in which the aircraft was first tested at the R.A.E. the suction had no effect on the drag. This was found to be partly due to the fact that the transition on both upper and lower surfaces of the wing, as observed by Gray's chlorine method, was occurring at about 0.06c, where there was a ridge almost 0.01in high in places caused by a butt joint in the skin. The surface waviness was also of rather a poor standard.

With this forward transition the boundary-layer thickness at the slot was such that it would have required twice the available suction to produce the desired effect.

The surface, therefore, was painted and rubbed smooth, removing the ridge at the skin joint to negligible proportions, and reducing the waviness. The transition was then found to be about 0.70c on the lower surface and 0.55c on the upper surface (at C_L=0.2). The transition was thus slightly aft of the maximum suction on both surfaces so that further improvement of the surface would have been unlikely to have had much effect.

Even with this improved surface condition the suction still seemed to have only a small proportion of the expected effect. This was eventually found to be due to the fact that the local C_Q actually being achieved at the test section was only about half the required value. This loss was found to be partly due to leaks in the duct system and partly to non-uniformity in the spanwise distribution of flow in the slots, caused by variations in slot width and by the internal design of the ducts.

One of the wings was removed from the aircraft and tested in the No. 2 11¼ft tunnel at the R.A.E. These tests confirmed that when the value of C_Q at the slots was increased to that theoretically required (about 0.0006) the expected gain due to the suction was realized, the section profile-drag coefficient being reduced to about 0.002.

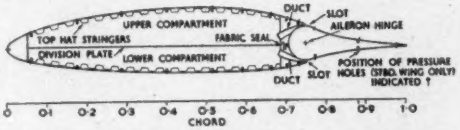


Fig. 6. Section through Griffith suction wing (at test section) as fitted to a Meteor 3 outboard of the engine nacelles.

The aileron effectiveness, although substantially lower than on a standard Meteor 3, was considered to be adequate, even with suction off, in spite of the disturbed flow over the aileron surfaces in this condition. There was some aileron oscillation, the severity depending on the upfloat angle. With zero upfloat angle the oscillation was negligible. The longitudinal and directional handling characteristics of the aircraft were the same as those of a standard Meteor.

These experiments, although not entirely conclusive, served to demonstrate the following points in relation to possible applications of the Griffith wing principle:—

(1) It is still necessary with this design to achieve a very high standard of surface finish if the transition is to be got near enough to the slot to enable the full advantages of the design to be realized.

(2) The construction of the suction slot and the ducting must be such as to guarantee a reasonably uniform flow distribution in the slot.

(3) Lateral control characteristics can be made acceptable even with suction off, at any rate for the moderate wing thickness of 16 per cent used in these experiments.

Concluding the first section of his paper, Mr. Davies referred to the measurement of overall drag in flight which fortunately is one of the few problems which has become easier since the advent of jet aircraft. It was fairly easy to measure the thrust of a turbojet in flight, using a pitot in the jet-pipe and, since the technique could be extended to apply in dives as well as in level flight, measurements of drag could be obtained at speeds well above the maximum level speed of the aircraft. Perhaps the most important objective of measurements of this kind were to provide a check on wind tunnel tests.

The lecturer said: "On the whole these comparisons were very encouraging in confirming the reliability of predictions based on wind tunnel tests. Considerable discrepancies might be expected, however, when separation effects are present in the drag. Such effects usually contribute to the increase in drag of an aircraft with increasing incidence, i.e., to the so-called induced drag factor K. Unfortunately the measurement of K in flight is not easy, because of the difficulty of separating out the effects of varying Reynolds number and lift coefficients.

"Lift coefficient also has an important effect on the drag rise at high Mach number. It is not really possible at these high Mach numbers to represent the effect as a variation in K, since the total drag is no longer even approximately a linear function of C_L."

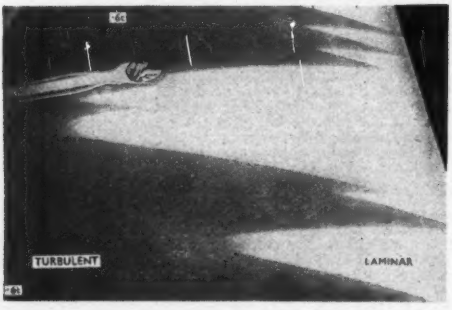
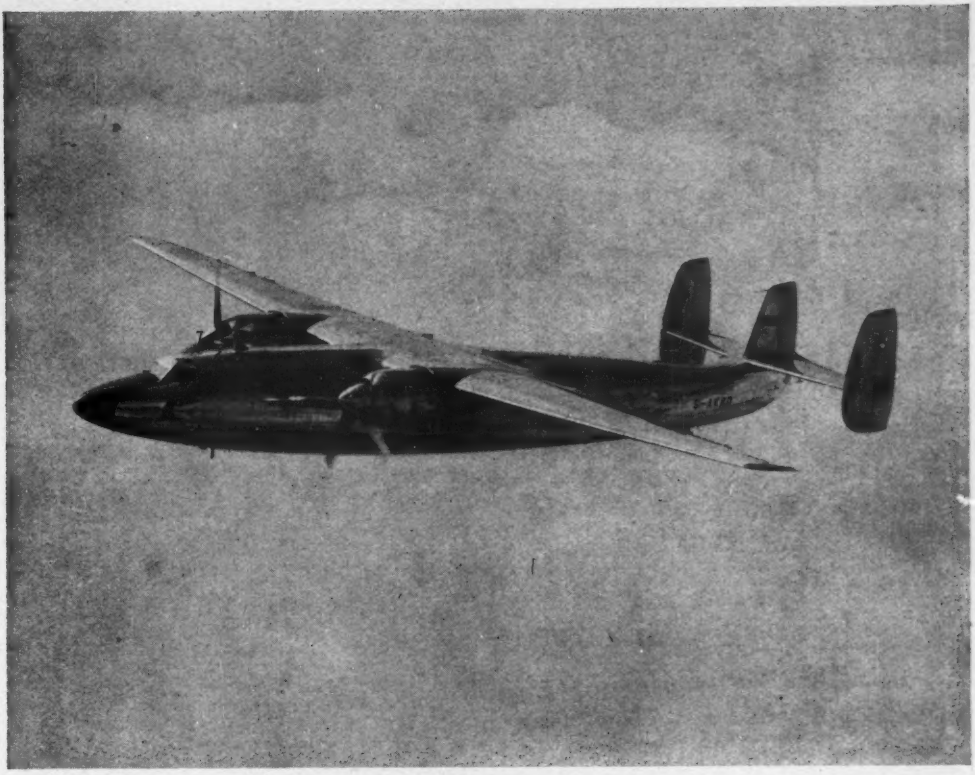


Fig. 5. Wedges of turbulent flow caused by insects on the leading-edge.



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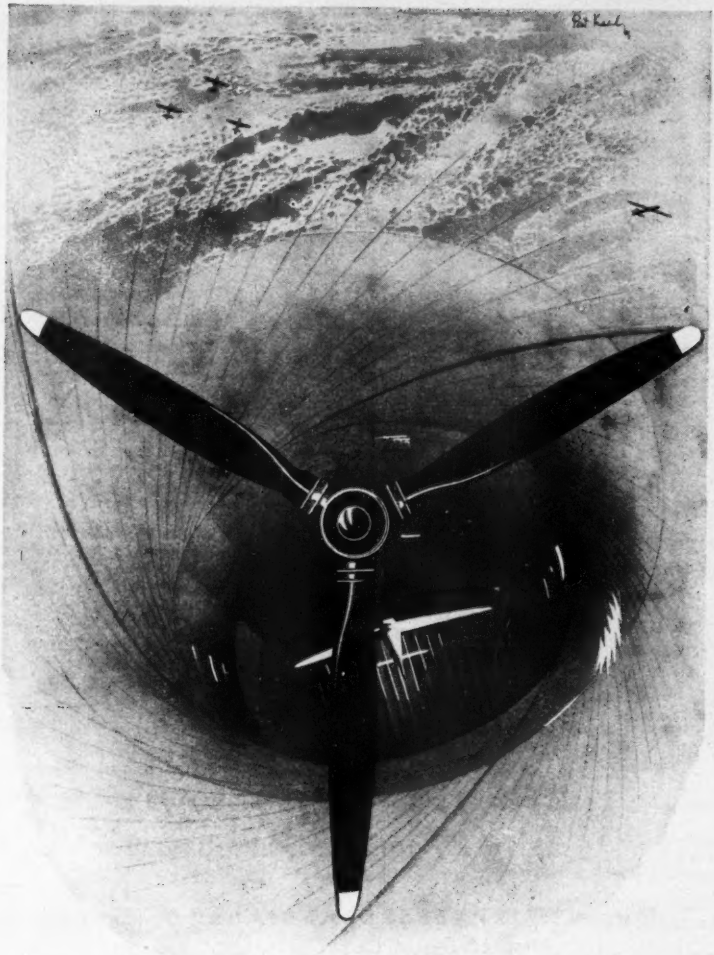

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F. 215

Features of the Scorpion apparent here are the slim fuselage, thin, low-aspect-ratio wings and large tip-tanks. The second prototype is shown.

ALL-WEATHER FIGHTER

Features of the Northrop F-89A Scorpion, Designed for Night and Bad-Weather Interception: Production for U.S.A.F.

RADAR aids have enabled the bomber of to-day to seek out and destroy its target in darkness or through cloud. The defending fighter likewise uses radar to find its quarry under similar conditions. Such an intercepter, with its crew of pilot and radar observer, its airborne-interception equipment, and aids to navigation and landing, is of necessity a relatively large and complex aircraft. A typical example is the Northrop F-89A Scorpion, which has an all-up weight greater than that of a bombed-up Wellington.

The Scorpion, which was one of the first jet-powered all-weather fighters built in America, is a descendant of the Northrop F-61 Black Widow, itself the only American night fighter designed as such during the last war. When the prototype Scorpion made its first flight on August 16th, 1948, the U.S.A.F. had already ordered in quantity its Curtiss counterpart, the Blackhawk. Within two months, however, the Curtiss contract was cancelled, and Northrop's received an order for 48 Scorpions, later increased to 112. This total was further increased after the beginning of the Korean crisis, and F-89 production has since been speeded up. As an interim measure, the U.S.A.F. ordered a substantial number of Lockheed F-94 single-jet all-weather fighters; this design, being based on the T-33 two-seat Shooting Star, was amenable to quick production.

The all-weather fighter is still a comparatively rare species; the Avro Canada CF-100 (which probably has a higher performance than the Scorpion) is the only aircraft of this type being produced within the British Commonwealth. This brief survey of the American aircraft, though limited by security restrictions, is therefore of particular interest on this side of the Atlantic.

The Scorpion fuselage has a particularly high fineness-ratio. Its nose is occupied by the radar scanner, behind which are mounted the six 20-mm guns and their ammunition. Pilot and observer sit in tandem ejector seats inside the pressurized cockpit, covered by a one-piece canopy. The rear fuselage sweeps up to hold the single fin and high-mounted tailplane clear of exhaust gases and wing-wake. In overall layout, the Scorpion is reminiscent of the Bell XP-59, America's first jet aircraft; the resemblance stems largely from the installation of the two power-units, which are slung beneath the mid-wing on either side of the fuselage. The turbojets are Allison J-35-A-21s, axial-flow units rated at 4,900 lb each (6,800 lb with afterburning).

Internal fuel tanks are situated in the fuselage—immediately aft of the cockpit—and wings. Large tip-tanks are also provided and are, apparently, integral structures.

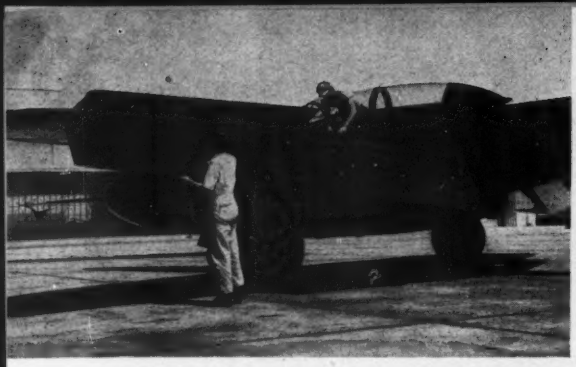
The straight wings are reported by one American source to give "the same drag-alleviation or increase in critical Mach number as would a wing sweep of 35 deg." This low drag-coefficient at high speeds is said to be a function of low thickness-ratio (only 8½ per cent at the root, 7½ per cent at the tip) and low aspect-ratio. The deep root-chord of 15ft was, in any case, necessary to maintain the wing thinness while accommodating a structurally sufficient main spar.

Full hydraulic power is provided for all the controls, which themselves form one of the most interesting design-features of the Scorpion. The Black Widow employed "retractable" spoiler-type ailerons and its jet successor is equally unorthodox in using split ailerons or "decelerons." In normal flight the upper and lower sections of the aileron are joined and function in the normal way; for use as dive brakes they part, and present equal areas above and below the wing. On the landing approach, the lower segments move downwards in conjunction with the double-slotted flaps, providing, in effect, a full-span flap.

The undercarriage is of the nosewheel type, with main units retracting inwards into the wings. Narrow-section tyres, of nearly 200 lb pressure, are employed. The twin-wheel nose unit, placed behind the guns, retracts rearwards.

For electrical services, a 120-volt system is provided and,

The assembly line for Scorpions in Northrop's factory at Hawthorne, California. Before the outbreak of the Korean war, 112 Scorpions were on order for the U.S.A.F.; the contract has since been increased.



The Scorpion's "decelerons" combine the functions of ailerons and dive-brakes and, during the landing-approach, provide additional flap-area.

ALL-WEATHER FIGHTER . .

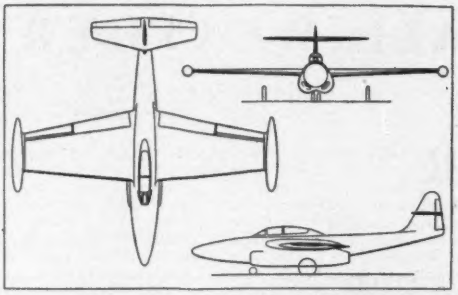
as might be expected, the aircraft carries much radar and radio equipment. Power is supplied to radar scanner and radar servo gear, indicator panels, gyros, V.H.F. sets, intercom, blind-approach equipment, radio compass, Zero Reader, navigational aids, radar gun-sight computer, gyrosyn compass and identification lighting. Windscreen de-icing is also electric, and hot air is supplied for anti-icing of wings and tail. Similar provision is made for the air intakes.

For ease of production the F-89 fuselage is split into two, and each half is built up separately. The halves are joined to a third component, the vertical firewall between the power-units, which comprises the keel structure.

Modifications to the original design of the Scorpion include the provision of new intakes with a boundary-layer gap between the intake-fairing and the fuselage, and the tapering of the nose to take advantage of a smaller-diameter radar scanner than that allowed for in the first prototype.

Another change is the introduction of fairings between the jet-pipe and the fuselage, following the adoption of Solar afterburners with adjustable nozzles.

As mentioned earlier, the requirements met in the specification of the Scorpion have resulted in an unusually large fighter: wing span is 56ft 2in, length is 53ft 5in, and height is 17ft 8in. Other details are restricted, but some specific figures quoted by *Aero Digest*—although described by the Northrop company as "unofficial"—are worthy of quotation. Empty weight is given as 19,800 lb and the normal gross weight as 32,500 lb; overload weight is said to be 40,000 lb. Maximum speed at sea-level, with and without afterburning, are quoted as, respectively, 675 m.p.h. and 706 m.p.h.; both figures seem optimistic. A cruising speed of 535 m.p.h. at sea-level is specified, and the combat radius is given as 875 miles. The service ceiling, officially described as "over 40,000ft," is reported to be 52,000ft, and the maximum range is stated to be 2,600 miles.



General arrangement of the Northrop F-89A Scorpion.

DIMENSIONAL

"*Engineering Metrology.*" *By K. J. Hume, B.Sc., A.M.I.Mech.E., M.I.Prod.E. Macdonald and Co. (Publishers) Ltd., 43, Ludgate Hill, London, E.C.4. Price 18s.*

A KNOWLEDGE of the practice of measurement is of vital importance to engineers, and it is therefore somewhat surprising to find that relatively little material, in a collected form, has been published on the subject. Mr. Hume, who is metrology superintendent to the de Havilland Engine Co., Ltd., deals extensively with the application of metrology in the field of mechanical engineering, and with the theoretical and practical aspects of dimensional measurement. He describes a wide range of modern instruments, apparatus and up-to-date methods employed.

Engineering Metrology is intended as a text-book for the technical-college student taking metrology or workshop technology in the examination for the Higher National Certificate in Production Engineering, the Institution of Mechanical Engineers, and the Institution of Production Engineers. It is straightforward and clearly written, whether it is dealing with the basic principles of mathematics and mechanics, the manufacture of gauges, with workshop processes, or with the complicated subject of screw-thread measurement.

LOOKING DOWN

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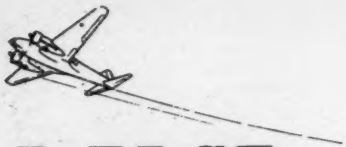
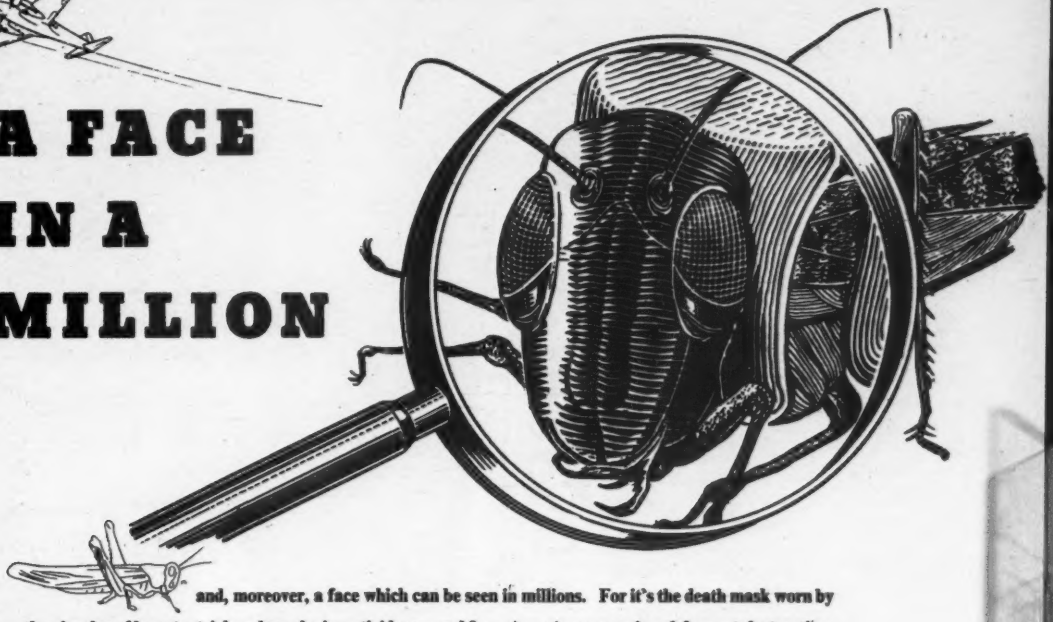
FORTHCOMING EVENTS

Feb.	23.	R.Ae.S.: Fourth Louis Bleriot Lecture: "Power versus Weight," by M. Maurice Roy.
Feb.	24.	Society of Licensed Aircraft Engineers: "Accident Investigation," by A.Cdre. Vernon Brown, C.B., O.B.E., M.A., F.R.Ae.S.
Feb.	24.	R.A.F. Reserves Club: Annual Ball.
Feb.	27.	R.Ae.S. Section Lecture: "Aircraft Wheels, Tyres and Brakes," by J. Wright, F.R.Ae.S.
Feb.	27.	R.Ae.S. (Belfast): "Aircraft Carriers," by J. L. Bartlett.
Feb.	27.	R.Ae.S. (Bristol): "Human Factors and Civil Transport Aircraft," by K. G. Bergin, M.A., M.D., D.Ph., A.F.R.Ae.S.
Feb.	27.	Society of Instrument Technology: "Measurement of Surface Temperature," by Dr. R. C. Parker.
Feb.	28.	R.Ae.S. (Manchester): Film: "Steel-making."
Mar.	1.	R.Ae.S.: "Towards Electrical Serviceability," by R. H. Woodall, A.F.R.Ae.S., and W. A. Higgs.
Mar.	1.	R.Ae.S. (Portsmouth): Film: "Wood."
Mar.	3.	British Interplanetary Society: "Combustion in the Rocket Motor," by Prof. A. D. Baxter, M.Eng., A.M.I.Mech.E., A.F.R.Ae.S.
Mar.	3.	Royal Navy v. Army Rugby, Twickenham.
Mar.	5.	R.Ae.S. (Halton): "Case for the Flying-boat," by D. Keith-Lucas, F.R.Ae.S.
Mar.	5.	Institute of Transport (Metropolitan Section): "Air Transport by Charter Companies," by Capt. R. J. Ashley.
Mar.	6.	R.Ae.C.: Film Show by C. Colin Cooper: "Helicopter Activities."
Mar.	6.	R.Ae.S. Section Lecture: "Pilot-ejection Seats," by J. Martin, O.B.E.
Mar.	7.	Royal United Service Institution: "The Campaign in Malaya," by A.V-M. Sir Francis Mellersh, K.B.E., A.F.C.
Mar.	7.	R.Ae.S. (Preston): "Air Operations in the 1914-18 War," by Capt. Norman Macmillan, M.C., A.F.C., A.F.R.Ae.S., F.R.S.A.
Mar.	7.	R.Ae.S. (Luton): "De-icing and Anti-icing Systems," by D. Rendel, B.Sc.
Mar.	7.	R.Ae.S. (Chester): "Undercarriages and Hydraulic Equipment," by C. B. V. Neilson, M.A., M.I.E.E., A.M.I.Mech.E., A.F.R.Ae.S.
Mar.	7.	R.Ae.S. (Leicester): "The Island Campaign" (colour film), by W. Courtenay, O.B.E., M.M., A.R.Ae.S.
Mar.	8.	Institute of Welding (South London Branch): "Welding Thin-gauge Stainless Steel," by C. Colley.
Mar.	8.	R.Ae.S. (Isle of Wight): "Methods of Timekeeping," by Dr. R. d'E. Atkinson.
Mar.	12.	R.Ae.S. (Derby): "Cierva Air Horse," by J. S. Shapiro, Dipl. Ing., A.F.R.Ae.S.
Mar.	13.	R.Ae.S. (Belfast): "Radar," by B. W. Hodlin, B.Sc. (Hons.).
Mar.	14.	R.Ae.S. (Brough): "Aircraft Structures," by P. B. Walker, M.A., Ph.D., F.R.Ae.S.



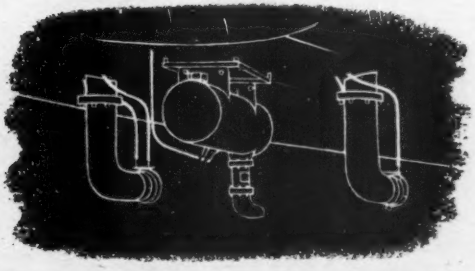
A FACE IN A MILLION



and, moreover, a face which can be seen in millions. For it's the death mask worn by countless hordes of locusts stricken down by insecticide sprayed from Avro Ansons equipped for pest destruction. This modern way of attacking inaccessible breeding grounds has proved the economy of using *suitable* aircraft.

Compare these operational requirements with . . . . . the Anson facts :

1. Two engines for safety over broken terrain.	*Two Armstrong Siddeley Cheetah engines which are renowned for their reliability.*
2. Manoeuvrability close to the ground.	*The Avro Anson's capabilities have been proved in large-scale spraying operations at low levels.*
3. Ability to operate from strips prepared near the dropping zone.	*At full load the Avro Anson takes off in 550 yards and requires only 300 yards from touch down to stop.*
4. Sturdiness to withstand damage in operations from rough, hastily prepared strips,	*The Avro Anson fuselage, of welded steel tubular construction, possesses great strength and resiliency and is capable of absorbing an unusual amount of severe handling.*
5. Reliability to ensure trouble-free operation away from permanent bases.	*The Avro Anson's reputation for reliability is the outcome of 15 years' service in all parts of the world.*
6. Appropriate insecticide capacity for operations which must be closely controlled by ground observation to avoid wastage.	*Two fuselage insecticide tanks, having a total capacity of 200 gallons, have proved adequate for a coverage of 1,000 acres in a single 20 minute sortie,*



ANSON

A. V. ROE & CO. LTD. MANCHESTER

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CHIPMUNK

A trainer for the Commonwealth and for the world

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DH AIRCRAFT

DH ENGINES

FERRY TO AMBASSADOR

A Record of Airspeed Achievement Over Twenty Years

THE Airspeed Ambassador is known as an aircraft of many virtues, not the least of which is that of being agreeably different from its contemporaries. And so it was with its forebears. Almost without exception these founders of the 20-year-old Airspeed tradition were, in one respect or another, unorthodox in design; all were endowed with fine flying qualities and unusually good operating economy. The story of their development, and of personalities and events which influenced their careers, is told here for the first time.

It would have been an assiduous reader, or one with a keen interest in commercial developments, who might have spotted the unobtrusive paragraph in *Flight* of March 27th, 1931, to the effect that a new limited company had been formed under the title of Airspeed, Ltd. Behind the cold formality of the announcement was a story which began when work ceased on the R.100 and when the technical staff concerned with that great airship were obliged to look around for positions elsewhere. Most of them were able to secure work with various aircraft firms; but two had previously decided to go one better and to establish their own company. They were Mr. N. S. Norway, formerly chief calculator to Sir Dennistoun Burney's Airship Guarantee Company, and the chief engineer, Mr. A. Hessell Tiltman, who had also, for some years, been a designer with the de Havilland Aircraft Company. Lord Grimthorpe became interested in the project, Sir Alan Cobham joined the board of directors and, with the help of a number of enthusiasts, the company was duly established in a small way, with offices and works at Piccadilly, York.

The first-born was Type AS-1—a single-seater sailplane of high performance and great beauty, which was named the Tern. It won high praise, even from some of the most experienced German pilots, and an example existed, we believe, as recently as 1948. But the AS-1 was not quite the first aircraft to be considered by the firm in its embryo. Tiltman and Norway had originally decided to try to form the company because they believed that there was a market for a "different" light aircraft and had gone quite a long way in the work of designing a high-wing three-seater cabin machine. With the limited funds available, however, the sailplane seemed to be the better initial project. Soon afterwards Sir Alan Cobham stated that he was ready to buy two multi-passenger aircraft, which were the next to be completed. They bore the type-number AS-4 and the name Ferry.

As already intimated, Airspeed transport machines have never slavishly conformed to the fashion of the day, and though the Ferry was the most motherly-looking of three-engined biplanes, it was nevertheless an aircraft with a difference. The cynic might admit the truth of this by virtue of the fact that, for good practical reasons, two of the engines were upright (Gipsy IIs) and the third inverted (Gipsy III). But the real character of the Ferry lay in its having been planned specifically as a short-range transport or joy-rider, with the requirements of Sir Alan Cobham's National Aviation Day Display foremost in mind. It was described by Messrs. Norway and Tiltman as having "a large cabin and a small petrol tank," and it was designed to carry ten or more passengers on a total of 360 h.p.—or, in other terms, 36 h.p. per paying passenger. As a passenger aircraft it possessed a psychological advantage over competitors in having three engines, for twenty years ago, as now, many aerial aspirants would fly happily behind multiple power plants, but would hesitate to entrust themselves to a single-engined machine.

Ten months or so after design work had started, the first

FERRY TO AMBASSADOR . . .

specimen was delivered to Sir Alan Cobham on April 24th, 1932, having romped (if the word is applicable to such a matronly form) through its Martlesham tests in four days and flown a total of 13 hours after its initial flight at Sherburn, in the hands of Captain H. V. Worrall. Throughout the summer, in company with a second example, delivered in early June, it continued to "pack them in" at the popular meetings then in vogue. On at least one occasion a Ferry-load of passengers was disembarked, the next batch (or clutch?) was seated, and the Ferry was away again in an elapsed time of 27 seconds. Small wonder that, when a *Flight* representative visited York in September, 1932, he met a "reasonable optimism" among the directors. A reckoning at the end of the joy-riding season showed that the two Ferries between them had carried about 90,000 paying passengers and made 9,100 landings.

As if to prove their versatility (though actually with plain commercial motives), the Norway/Tiltman team had already thought up the next aircraft and was working throughout the summer of 1932 on the design of the AS-5 Courier, a type very far removed in concept from the bestrutted, box-like Ferry. With its retractable undercarriage the Courier conformed to the newest American practice and was by far the cleanest British transport machine of its day. The design work had started in May and serious construction was well under way in September of that year. The maiden flight was made at Portsmouth by the renowned F/L. G. H. Stainforth on April 10th, 1933.

The construction of this first Courier was largely made possible by the fact that Sir Alan Cobham wanted such a type as a long-distance aircraft and was already interesting himself in the possibilities of air-to-air refuelling, which had already been used, in primitive form, by American endurance fliers.

Parallel with the construction of the first Courier, work was also in progress on a small two-seater pusher designed by Messrs. Shackleton and Lee Murray and known as the S.M.1; but this was in no sense an Airspeed design.

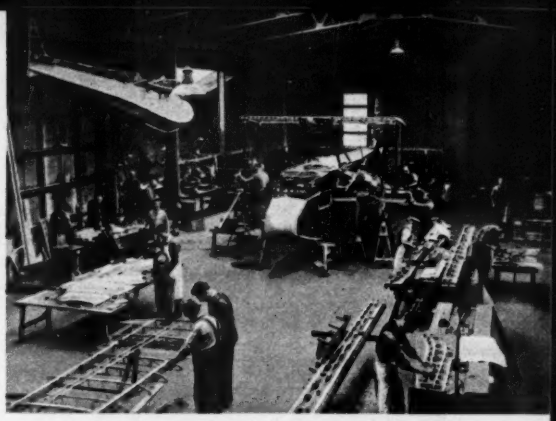
The Move to Portsmouth

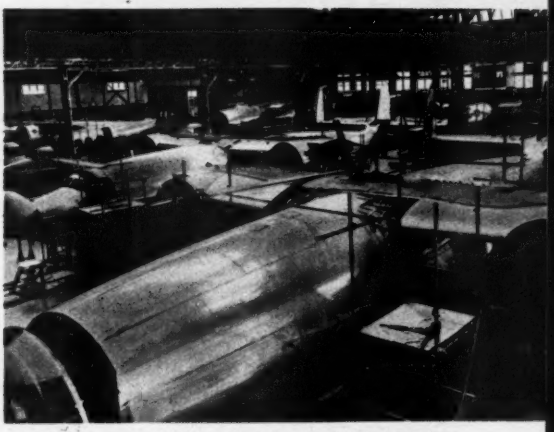
In March, 1933, Airspeed moved from York to their new factory at Portsmouth, the nearly-completed Courier being sent by road. On a site of four acres, reserved for expansion, this factory offered twice the floor area available at York, and was about ten minutes by car from the centre of the town. Furthermore, the factory was on its own airfield, whereas at York the Tern and Ferry had had to be transported by road to Sherburn.

By May a member of *Flight's* staff found that the company had quite settled down. A Ferry was under construction to the order of Mr. Sword, of Midland and Scottish Air Ferries, and another, then being laid down "on spec," was due to go to the same company. Our representative was not slow in accepting an opportunity to try out the new Courier, with which at that time Sir Alan Cobham and S/L. Helmore contemplated flying non-stop to Australia, employing flight refuelling. He was evidently much impressed by the Airspeed patent retractable undercarriage —and especially by the Klaxon horn, fitted in the circuit as a warning device, which gave a raucous howl if the throttle was closed before the undercarriage was right down. He discovered that the Courier reached an easy 160 m.p.h. on the full power from its Armstrong Siddeley Lynx (of only 240 h.p.), and had little doubt that the Townend ring cowling assisted materially in this most creditable achievement. The aircraft was, in fact, some 7 or 8 m.p.h. faster than the estimates had predicted, and the prototype had a level maximum speed of 163 m.p.h.

September 6th, 1933, was a red-letter day at Portsmouth, for on that date the first production-model Courier, with Lynx IVC engine, was formally handed over to the directors of Aircraft Exchange and Mart—Messrs. B. Brady and A. L. T. Naish—who held the sole selling agency at that time for England, Ireland and Wales. It was only a matter of days before this same Courier was off to Scotland to show that flights "fast enough to compete with the train service" were feasible; later the type was operated by London, Scottish and Provincial Airways on their London-Derby-Manchester-Glasgow service.

In December, Aircraft Exchange and Mart and R. K. Dundas, Ltd. (the latter concern held the Indian and Burmese agency), staged a demonstration at Hanworth, on which occasion a new Cheetah-powered "Colonial" version of the Courier, with a cruising speed of 152 m.p.h., appeared in company with a standard Lynx-engined model. A *Flight* representative who flew with Capt. Neville Stack recorded that the day was a bumpy one. His report sounds quaint to the modern ear: "After gaining height Capt. Stack began to draw in the retractable undercarriage. This is done by working a sort of pump handle, and one of the passengers jokingly remarked that he thought that for a moment Capt. Stack must have tried to fly the machine with the pump handle and to wind in the undercarriage with the joystick."





Below the twenty-year-old photograph of the original York factory (with the Ferry transport and Tern sailplane in evidence) is a view of the Airspeed works at Christchurch, showing production of Ambassadors for British European Airways as it appeared early in 1950.

The R.A.F. was not slow to appreciate the Courier's qualities and took delivery of a specimen early in 1934. This aircraft was later modified by Airspeed for experiments with flaps and eventually flew with a split flap ("Schrenk flap" in those days!) across the centre-section, two outboard Handley Page slotted flaps and drooping slotted ailerons—quite a modern set-up about which relatively little fuss was made at the time. In May that year two other Couriers, belonging to Bouts-Tillotson Transport, Ltd., inaugurated a trial goods service between London and Manchester. Sir Philip Sassoon, Under-Secretary for Air, Lord Brabazon (then Col. Moore-Brabazon) and assorted members of Parliament gathered at Hanworth to give their blessing to the project.

To the order of A. V.-M. A. E. Borton, director of D. Napier and Son, Ltd., one Courier was fitted with an H-type 16-cylinder Rapier engine, with marked benefit to performance. Meanwhile, work had been progressing on a twin-engined aircraft, later to be known as the Envoy, the decision to go ahead with this machine having been made as early as the autumn of 1933. Certification requirements were becoming more difficult by this time and the Envoy was probably the first civil aircraft for which a preliminary test-to-destruction wing specimen had to be made.

Thus, a beautiful debutante at the S.B.A.C. Display in July, 1934, was Airspeed's newest offering—the seven-seater twin-engined AS-6 Envoy, with two Wolseley A.R.9 radial engines of 185 h.p. each, giving a cruising speed of 150 m.p.h. In the hands of F/L. C. H. A. Colman the Envoy impressed all observers by its handiness and unusual quietness. Evidently the Airspeed star was in the ascendant, for in July also came the portentous announcement that an agreement had been reached between the company and Swan, Hunter and Wigham Richardson, Ltd., the great ship-building concern of Wallsend. This agreement, the registration of the new Airspeed (1934), Ltd., and its flotation as a public company, at last put the firm in a happier financial position. Like all small firms in that difficult

"Flight" photograph

Flight-refuelling trials with the first Courier in 1934, with S/L. Helmore officiating at the receiving end. The tanker was a Handley Page airliner, formerly in Sir Alan Cobham's National Aviation Day Display.

Well-pleased with the first production Courier are these original Airspeed directors: (left to right) N. S. Norway (now better known by his nom de plume, Nevil Shute), A. H. Tiltman, and Lord Grimthorpe (chairman). The beaming countenance on the left is that of Sir Alan Cobham, another Airspeed pioneer. "Flight" photographs

period of industrial depression, Airspeed had had to fight hard to remain alive. Only the faith and enthusiasm of its few backers had kept it going from year to year.

During the year Sir Alan Cobham, in company with S/L. Helmore, persevered with the Courier's flight-refuelling tests, the tanker being one of Sir Alan's Handley Page W.10s. The Air Ministry had been showing a practical interest in the scheme after it had been proved to be feasible and Flight Refuelling, Ltd., was formed as a company during the year. The project for the non-stop flight to Australia had by this time been abandoned, but it was still proposed to fly to India, where Lord Ronaldsway, chairman and managing director of R. K. Dundas, Ltd., was engaged later in the year on a Courier demonstration tour. On this flight to India, attempted in September, 1934, the Courier got not further than Malta where, after a successful refuelling contact, a minor mechanical fault necessitated a forced landing.

Meanwhile, for the MacRobertson England-Australia race in October, 1934, a development of the Envoy, bearing the type number AS-8 and named the Viceroy, was prepared. It was fitted with two of the latest supercharged Armstrong Siddeley Cheetah VI engines, each delivering 315 h.p. at 7,000ft. Among notable technical departures in this aircraft was the fitting of long-chord N.A.C.A.-type cowlings, with inter-cylinder baffles and annular oil coolers forming the noses of the cowlings. A 270-gallon fuel tank was installed on the port side of the fuselage. To expedite testing, a Service pilot flew down to Portsmouth so that it was not necessary for the machine literally to "go through Martlesham." Piloted by Capt. T. Neville Stack and Mr. S. L. Turner, the Viceroy made an excellent impression when, in company with S/L. D. E. Stodarts' Cheetah-engined Courier, it was flown over to Mildenhall on the Sunday afternoon preceding the great race. But, after its hurried preparation, fortune did not smile upon the Viceroy; it was forced down in France and eventually retired from the contest at Athens. The Courier pressed on valiantly and was eventually placed sixth in the "speed" section of the race. Later in the year Airspeed indirectly suffered a setback when Mr. C. T. P. Ulm's Envoy, being flown on a survey flight from the U.S. to Australia, was lost in the Pacific near Honolulu.

In January, 1935, the company increased its capital with a view to financing developments made possible by an agreement which had been entered into with Mr. Anthony Fokker. This included an exclusive licence to manufacture Fokker-designed aircraft and to sell them within the British Empire, and authorization to manufacture and sell in the British Isles the Douglas DC-2, for which Fokker held the European licence. The services of Mr. Fokker were also secured as technical adviser.

Having found great difficulty in obtaining qualified personnel, and realizing that this difficulty was shared with similar firms, the company founded the Airspeed Aeronautical College at Portsmouth Airport, offering courses for those who wished to enter the aviation industry. A further enterprise at this time was the service station at Portsmouth, which undertook C. of A. renewals and all forms of aircraft repairs.

During the year the Envoy was making friends in many parts of the world. The Japan Air Transport Company wrote to express its satisfaction with its recently acquired example, already in regular service in and to Manchuria. The Japanese, in fact, ordered six Envoys and later bought the licence to manufacture the type. In Czechoslovakia, two Envoys, with indigenous Walter Castor II engines, were making survey flights between Prague and Moscow, preparatory to the opening of a new service, and two more Envoy IIs were purchased by Czechoslovakian State Airlines in the following year. At Riga, Latvia, an Envoy made several demonstration flights to the satisfaction of the authorities and officers of the Flying Corps. One of the earliest Envoys had been sold to Ansett Airways, of Melbourne, and with this aircraft and a Fokker Universal Mr. R. M. Ansett started his services in 1936; this Envoy is, so far as we know, still flying.

Toward the year's end an order was announced from the South African Government for seven Series II Convertible Envoys. Of these, four were to be civil machines, for South African Airways, and the remaining three would carry military equipment in the shape of a Vickers gun for the pilot, a Lewis in a manually operated Armstrong Whitworth turret atop the fuselage, and sixteen 20 lb or three 100 lb bombs. Cheetah IX engines were specified and split trailing-edge flaps were fitted. Deliveries were made during 1936.

At this time split flaps were a much-discussed novelty and *Flight* reported on the flapped Envoy Series II in March, 1936. "Certainly," it opined, "there can be few transport aeroplanes with an approach as steep as that of the latest Envoy with its split trailing-edge flaps lowered. Furthermore, this machine can be brought in safely at a speed which would hardly be credited by anyone who had not actually watched the A.S.I." The stalling speed of the Envoy was, in fact, reduced by 9 m.p.h with the help of the flaps, and the landing run was "halved." In every way the Envoy Series II was a remarkable machine, epitomizing Airspeed's constant aim for high performance for a modest power expenditure.

During 1936 announcement was made of the AS-14 transport —named, interestingly enough, the Ambassador—and a mock-up was built at Portsmouth, though it was not intended to build the type save to special order. A ten/fifteen-passenger high-wing monoplane of mixed construction, with two Pegasus engines, the AS-14 would have embodied the latest Fokker and Douglas techniques and was designed to cruise at more than 180 m.ph. and to offer a climb of 2,000 ft/min at take-off power.

One of the largest and fastest machines entered for the 1936 Schlesinger England-Johannesburg race and certainly the best equipped, was a stock-model Series II Envoy, slightly modified and flown by Capt. Max Findlay and Ken Waller. Misfortune overtook the machine at Abercorn, Northern Rhodesia. It seems that the wind direction was such that the only possible take-off

FERRY TO AMBASSADOR . . .

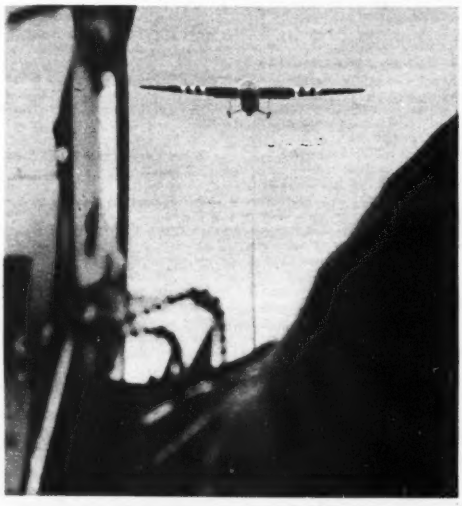
was both uphill and towards some trees. Notwithstanding advice to the contrary, Findlay took off and struck the trees; both he and Mr. Morgan, the radio operator, were fatally injured. Ken Waller and the other occupant, Mr. Peachey, were little hurt.

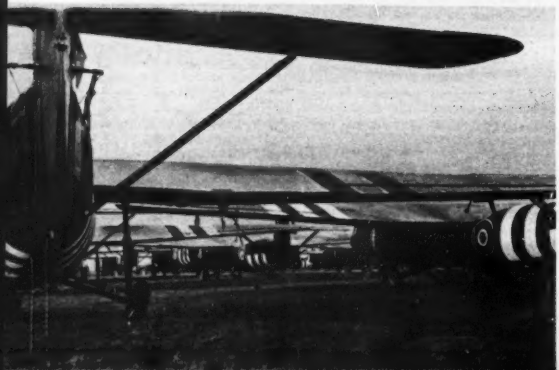
Late in 1936 the company announced the Series III Envoy, characterized by stressed-skin, plywood-covered wings, which obviated the Warren-girder inter-spar bracing.

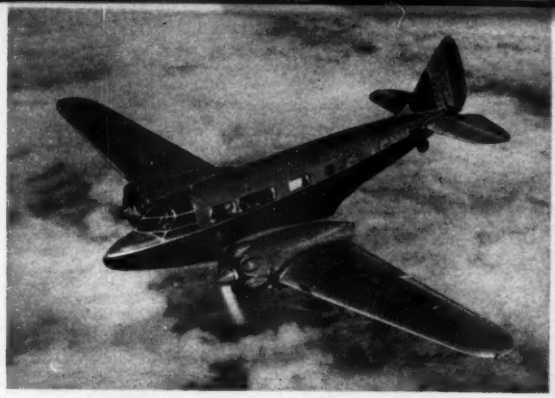
At the annual general meeting on the last day of 1936, the chairman—then Mr. George Wigham Richardson—said he was disappointed to have to present accounts showing a loss on the year's trading. This state of affairs was almost entirely due to the smallness of the turnover. Contracts, however, had been received from the Government for three different types of military aircraft, and the total value of orders on the books for civil and military machines was about £700,000. So future prospects were certainly not unfavourable.

It transpired that one of the military types to which the chairman had referred was the AS-10 Oxford trainer, a development of the Envoy and destined to become the most famous of Airspeed products up till the immediate post-war period. Apart from functioning as a transitional trainer for flying instruction including instrument flying, it was designed to provide for tuition in navigation, night flying, radio, gunnery and vertical photography. The invitation to submit designs for such a trainer had been received in 1935 and considerable development from the originally considered Envoy was natural enough in view of the varied requirements. The other two aircraft mentioned were, no doubt, the target aircraft Queen Wasp

The "Flight" photograph immediately below was secured on passage to Arnhem, and depicts a Horsa glider as seen from its Stirling tug. Horsas of the Arnhem force, arrayed before departure, are seen in the second picture. A powered Horsa was projected, but never built.







The beautiful Envoy for the use of Royalty and State personages.

(colloquially known as the "Clay Pigeon" at one period), which was under construction, and a "special defence machine." This aircraft was designed to trail cables carrying explosives and was not further developed because its role was, of course, superseded by the barrage balloon.

Envoys continued to sell strongly, not solely to commercial operators, but among private owners as well. Two superb examples went into the services of the Maharajahs of Jaipur and Indore, and a third to the managing director of a great Czechoslovakian steel corporation. It is interesting to remember the relatively low cost of aircraft in those days. One of the earlier standard Envoys was priced at £4,500, while the Couriers had been sold for £3,200 and the Ferry for a figure as low as £3,975.

In April, 1937, the news came out of a special Envoy for the transport of Royalty and State personages, accommodating four passengers. The aircraft carried a steward and wireless operator in addition to W/C. (now A.Cdre.) E. H. Fielden, the chosen pilot.

The year 1937 found F/L. Colman and Mr. G. B. S. Errington, the chief test pilot, making the longest delivery flights attempted up to that time. In Cheetah IX-engined Envoys they flew the 9,000 miles from Portsmouth to Lin Chow, in China. Mr. Errington, whose departure date coincided with the arrival of the monsoon, nevertheless made the trip in 53 flying hours, averaging 168 m.p.h. and suffering no serious trouble en route.

The park of new and experimental types at the R.A.F. Display of that year contained, in addition to the prototype Oxford (L4534), the first Queen Wasp target machine, which, with its neatly cowled Cheetah engine, tapered biplane wings and generously fenestrated cabin, looked much too good to be shot down into the sea. Wheel and float undercarriages were quickly interchangeable. Catapult trials of a Queen Wasp floatplane were later made from H.M.S. *Pegasus* (formerly *Ark Royal*) by F/L. Colman.

The Royal Envoy (G-AEXX) was prominent in the news during May, 1938, when, on the 9th of that month, the King made a tour of four R.A.F. stations—Northolt, Harwell, Upavon and Thorney Island. At the Central Flying School, Upavon, His Majesty saw some of the recently delivered Oxfords at work. Shortly afterwards—in June—it was announced that an additional order for these trainers had been placed with Airspeed, and it was further disclosed that the type was to be built by the de Havilland and Percival companies. So to Airspeed came the honour of being the youngest firm in the industry to have its products built by outside contractors.

Certainly the Oxford made an excellent impression on the *Flight* representative who air-tested it. "It would probably not be an exaggeration," he wrote, "to say that in the Airspeed Oxford a really modern array of controls and instruments has been planned in complete detail, and as a whole, almost for the first time . . . . The planning of the cabin is such as would please even the pilots who are familiar with some of the much-praised American transport aeroplanes . . . . The controls appear to be everything that they should be, and the aileron control in particular is a good deal more pungent than is usually expected in comparatively large aeroplanes."

Overseas air forces were showing marked interest, and five Oxfords were acquired by the Royal New Zealand Air Force. A visitor to Portsmouth during September was Air Marshal Sir Philip Joubert de la Ferté, Air Officer Commanding R.A.F. India, who took delivery of the first of two Envoys for the Communications Flight in his Command. They were to be at the disposal of His Excellency the Viceroy and, apart from the cabin arrangement, were similar to the machine used by His Majesty the King.

One of the Air Ministry Oxfords was civil-registered and

diverted to British Airways. It was specially equipped for blind approach and D/F. experimental work from the enlarged airfield at Heston. The latest radio was installed, and provision was made for the use of an observation dome in place of the gun turret.

At the end of 1938 the chairman was able to report a profit on the year's trading. He referred to factory extensions to allow the fulfilment of increased Government orders and reported that Oxford deliveries were ahead of contract schedule. Symptomatic of the company's developing stature was the attendance of 500 employees at the annual dinner in 1939. One speaker referred to a remark by Sir Kingsley Wood, the Air Minister, that the firm "had never let the Air Ministry down."

In June, 1940, formal announcement was made that the de Havilland Aircraft Co., Ltd., had completed negotiations for the purchase from Swan, Hunter and Wigham Richardson, Ltd., of that firm's holding of Airspeed ordinary shares. Airspeed, however, retained its identity as a separate company—as, indeed, it still does, though now a wholly-owned subsidiary of The de Havilland Aircraft Company.

The war years were, of course, complicated by a number of events—not excluding the air raids on Portsmouth and the completion of the shadow factory at Christchurch, which was managed by Airspeed and is now not only the home of the Ambassador, but the design and business centre of the company, though Portsmouth still remains the head office. In general, it can be said that the Portsmouth factory continued to be the main centre during the war, with the production drawing-office continuing its work there; but the project design team made a number of moves which culminated, in 1944, in the final colonizing of Christchurch, where, gradually, a new team settled down after their peregrinations. There, in 1945, the first mock-up of the Ambassador was built and the prototype aircraft began to take shape.

War-time Prototypes

At the start of the war, work had been proceeding on the design of the AS-45, a Mercury VIII-engined trainer intended to displace, if deliveries slowed down, the Harvard. Two of these aircraft were eventually made and flown. During the same period, too, the first of two AS-39 Fleet Shadower aircraft, with four Pobjoy Niagara engines, had been completed. This aircraft, though interesting as a means of providing the maximum of endurance with the minimum in the way of controllable speed, was the result of a Naval requirement which duly fell by the wayside as war experience was gained and its value doubted.

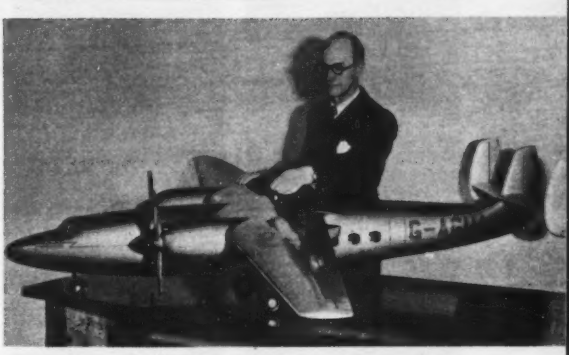
War experience, too, was responsible for the decision to move the design team in 1941 from Portsmouth to Hatfield, where, with the D.H. Technical School as a drawing office, design started on the AS-48 Sabre-engined night fighter. This project was dropped in favour of twin-engined aircraft such as the Mosquito. Another aircraft on which the Airspeed team worked was the AS-49 single-seat fighter-trainer with a Gipsy Six engine. One of the relatively few technically destructive enemy raids on this country—a hit-and-run affair by a Ju88 on Hatfield—wound up this project. All the design calculations were burned and the mock-up was destroyed on that day in October, 1940.

Towards the end of that year, however, work was started on the design of a troop-carrying glider and this, the AS-51 Horsa, was destined to be one of the most successful aircraft of the war era. The specification reached the Airspeed team—then installed in Salisbury Hall, Hatfield—in December, 1940, and the prototype was flown from Fairey's Heathrow airfield (now extended into London Airport) nine months later. The design was "productionized" by the drawing office at Portsmouth and the work of construction was divided amongst firms throughout the country, the aircraft sections being assembled at Maintenance Units. The story of the Horsa and of its quantity production, however, interestingly vital though the work was, can hardly find a place in this outline history of Airspeed.

The nucleus of the design team returned to Portsmouth in the early part of 1942, where they worked on the powered version of the Horsa, which was to be fitted with two Cheetahs, and on the AS-55, a four-Hercules XIV-engined commercial freighter project.

Meanwhile, Mr. A. E. Hagg, previously chief designer for de Havillands (where he was responsible for, among many other famous D.H. aircraft, the Albatross airliner) and, later, designer in charge of the installation department of Napiers, had been concentrating his energies on air-sea rescue and R.A.F. tender design. He first came into the Airspeed picture in 1942 when, working with two members of the Airspeed design team, he started, at the invitation of the M.A.P., on the AS-56 Sabre-engined fighter. The principal novelty in this design was the adoption of the fan-cooled annular radiator. As an Airspeed project, this aircraft was dropped, but Napiers continued with the development of the radiator.

However, following the recommendations of the Brabazon Committee, Airspeed were asked to design a Dakota replacement—the Brabazon Type II—which, while intended eventually for post-war civil use, was justified, too, as a prospective military transport. Mr. Hagg was asked to take charge of the design and the nucleus was built up at Fairmile Manor, Cobham, Surrey, before eventually emigrating to its final home at Christchurch, Hampshire—where, at that time, there was no drawing-office accommodation.

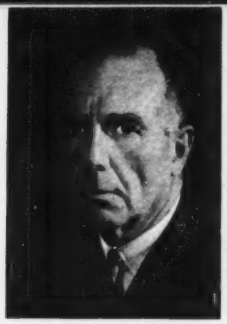


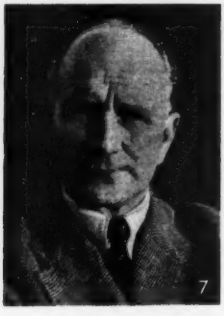
Mr. A. E. Hagg, Ambassador designer, appraises an early scale-model.

The initial designs for the AS-57 Ambassador envisaged the use of a pair of Hercules engines and an all-up weight of the order of 35,000 lb, but investigations soon showed that this particular formula would not be able to better the performance of the Albatross of 1938 when carrying all the equipment and with the features likely to be demanded in all post-war aircraft. Still determined to retain the advantages of the twin-engined arrangement, the designers looked for a more powerful engine of the same general design and decided on the Centaurus, which was then in its production infancy. As the work proceeded it became obvious that the Centaurus-engined Ambassador would be able to offer something quite exceptional in the way of a payload/range performance, with a high cruising speed for a small power-output and an attractive reserve to deal with engine failure. Mr. Hagg, as technical director and chief designer of the firm, insisted on the need for an exceptionally clean design and the result was the original 45,000 lb aircraft with an 8,000 lb payload. Later, work on the AS-60 Ayrshire—a militarized version—caused the structure-strength to be stepped up and, coupled with the expectation of greater take-off power from the Centaurus, permitted weights of the order of 52,000 lb to be considered. In this initially developed form the Ambassador was eventually ordered by British European Airways and production was started early in 1948 at the Christchurch factory, while detail fabrication of the sections other than the fuselage was planned and got under way at the firm's Portsmouth works. There were to be further design developments and 1951 was agreed as the target year for first deliveries.

From 1941 onwards the Christchurch shadow factory had been concentrating on the production of Oxfords, Horsas and, later, of Mosquitoes. The great majority of the Oxfords were, of course, made at Portsmouth and at the various outside contractors' factories, but Christchurch made a good start with some 550 Oxfords before turning to Horsas. These aircraft, as already explained, were made in sections throughout the country and the Christchurch factory was the only civil centre where complete machines were made. Some 700 Horsa Is and IIs were made or assembled before the works turned to Mosquito 6

At Farnborough in 1948 the Ambassador took off, demonstrated, and landed without starting the port Centaurus. Mr. Errington was the pilot.





(1) *Major Hereward de Havilland, D.S.O. (joint managing director).*

(2) *J. Liddell (joint managing director).*

(3) *A. Townsley (director).*

(4) *P. E. Gordon-Marshall (director).*

(5) *W. F. Shaylor (director).*

(6) *G. H. Miles (chief designer).*

(7) *G. B. S. Errington, O.B.E. (chief test pilot).*

FERRY TO AMBASSADOR . . .

fighter-bombers, Seafire conversions and Mosquito 35s.

In 1945 the new drawing-offices, research laboratories and technical block were at last ready for habitation. The design team, which had moved to Christchurch from Cobham in September, 1944, settled in and was slowly built up to deal with the development of a modern civil airliner. The first hand-made Ambassador prototype flew in July, 1947, while the second —also the work of the experimental department—was well under way. This second prototype was pressurized and was structually planned to take four turboprop units. The decision by B.E.A. to purchase piston-engined Ambassadors, however, caused the turboprop project to be dropped for the time being, and the second prototype flew with Centaurus engines in August, 1948. The many changes and developments envisaged in the eventual production aircraft necessitated a third prototype—which was, in fact, to be made on the production lines and to be fitted with the new Centaurus 661 engines. This aircraft flew in May, 1950, and the first production aircraft for B.E.A. took the air last month.

While the greatest attention was naturally focussed on the Ambassador, Airspeed had, soon after the war, realized that there would be a considerable demand for aircraft in the smaller passenger-carrying class and that new types would not be available in time to meet this demand. Hence the development of the Consul—a civil version of the Oxford. With, as was expected, the indifferent transport facilities of the immediate post-war period and the rapid increase of charter work, the Consul, which could be produced quickly and cheaply, proved immensely popular and some two hundred were sold to operators at home and abroad. This very considerable production was handled by the Portsmouth factory which, since the war, and apart from Ambassador detail production, has been working at full pressure on the manufacture of Vampire fuselages and other sub-contract work for de Havillands. Adaptation of the Vampire for training duties is a recent Airspeed accomplishment of particular merit.

Since Airspeed's formation in 1931, there have, of course, been many changes, though fourteen of the original York members of the firm still remain. Of the early management, Mr. N. S. Norway resigned before the war to devote his time to writing and has become famous, under the *nom de plume* Nevil Shute (his first names), as a novelist. Mr. A. Hessell Tiltman resigned in 1942 and is now a director of the Tiltman-Langley Laboratories. Capt. T. E. Laing, first on the list of those who helped to finance the company at York, was works manager at Christchurch at the time of his death, in a car accident, three years ago. Mr. A. E. Ellison, one of the initial design team at York and responsible, as assistant chief designer, for most of the general work on the Ambassador, left the firm two years ago to take up an appointment with the English Electric Company. Of later Airspeed personalities, Mr. A. E. Hagg—to whom all the credit for the conception and initial development of the Ambassador must go—retired from the board of the company in 1949. The present Airspeed board and management list is given on this page.

In recent years there has been an even closer liaison between the Airspeed and de Havilland companies, culminating eventually in their complete financial union. Though now very much a company in the de Havilland group, the firm continues to retain independence of action in all matters except those of major policy. Airspeed, in fact, and through all the vicissitudes of its career, has remained—Airspeed.

PERSONALIA—

Directors.—W. E. Nixon (chairman), F. T. Hearle, F. E. N. St. Barbe (de Havilland directors); H. de Havilland, D.S.O., J. Liddell, Airspeed (joint managing directors); A. Townsley, P. E. Gordon-Marshall, W. F. Shaylor.

Management.—G. H. Miles (chief designer), H. V. Clarke (chief engineer), G. B. S. Errington, O.B.E. (chief test pilot), H. W. Denny (works manager, Portsmouth), F. J. Jupp (works manager, Christchurch), J. Johnston (chief draughtsman), J. F. Foss (chief aerodynamicist), R. A. H. Johnson (chief structures engineer), W. W. Warner (service manager), H. A. Taylor (public relations and technical sales).

Old-timers (*personnel who were at the York factory and are still with the firm*).—F. G. Cutter (personnel manager), C. Wright (woodwork sub-foreman), R. W. Jones (senior inspector), G. H. Cherry (aircraft inspector), W. Taylor (planning engineer), R. M. Renton (aircraft inspector), J. E. Collins (foreman fitter), R. Durkin (machine-shop foreman), G. Wrigley (aircraft inspector), W. Gee (woodwork inspector), T. A. Wilkinson (wood-detail inspector), R. Watson (outside technical representative), S. Morris (aircraft inspector), G. Elliott (rate-fixer). *The three last-named are at the Christchurch factory, near Bournemouth; the others are at Portsmouth.*

—AND PRODUCTION

War Production

Oxfords.—At Portsmouth, 4,411; Christchurch, 550; Hatfield, 1,515; by Standard Motor Co., Ltd., and Percival Aircraft, Ltd., 2,275. Total, 8,751. Rebuilt by daughter firms, 2,576.
Horsas.—At Christchurch, 695; sub-contracted, and assembled by R.A.F., 2,960. Total, 3,655.

Post-war Production

Consuls, 138; **Consul** ambulances, 23; **Oxford** conversions, sundry, 46. Total, 207.

"Pre-Oxford" Production

(*Aircraft produced between* 1932 *and* 1937)
Ferry, 4; Courier, 16; Envoy I, 18; Envoy II, 12; Envoy III, 13.

FERRY TO AMBASSADOR . . .

The Tern high-performance sailplane of 1932, first Airspeed production.

AIRSPEED TYPES

Tern

THIS high-performance sailplane was designed to have the same degree of aerodynamic cleanness as its excellent German contemporaries, but to be far more readily assembled from the completely dismantled condition. In its time the Tern held the official British records for height and distance.

Span, 50ft; wing area, 201 sq. ft; wing loading (approx.), 2 lb/sq ft; speed, 35-40 m.p.h. (corresponding gliding angle about 1 in 20).

Ferry

THE ten-seater three-engined Ferry was notable not only for remarkable economy of operation but for quick take-off at full load. Each wing and centre-section had two box-spars, with spruce flanges and plywood walls; drag loads were taken by steel-tube compression members and tie rods. The fuselage was mainly a normal box-type structure with spruce longerons and frames covered with birch three-ply. One inverted D.H. Gipsy III engine was mounted on the upper wing and two upright Gipsy IIs on the lower wings.

Span, 55ft; length, 39ft 8in; gross weight, 5,600 lb; wing loading, 8.7 lb/sq ft; cruising speed, 85-90 m.p.h.; stalling speed, 49 m.p.h.; take-off run in still air, 200 yd; initial climb, 520ft/min; range, 320-340 miles.

Courier

BASICALLY a four/five passenger monoplane, the Courier was supplied in several forms. The "English" model had an Armstrong Siddeley Lynx IVC engine, while the so-called "Colonial" and overseas versions were generally fitted with Cheetah Vs. A Canadian model had a Wright Whirlwind R-760-E and was of metal construction, with the exception of the wings and tail. It had provision for a fixed undercarriage with ski attachment or, alternatively, floats.

The Courier wing was built round two box-spars of spruce and birch three-ply. The birch ply consisted of three laminations, the middle one being twice the thickness of the outer layers; the grains ran at 45 deg to one another. The fuselage was in three sections, the first of welded steel tubes, and the middle and rear sections having spruce longerons and bulkheads, with plywood covering. One of the Courier's most remarkable features was, of course, the Airspeed hydraulically retractable undercarriage, with Dunlop wheels and brakes. The enclosed cabin seated a crew of two and four or five passengers.

Span, 47ft; length, 28.5ft; wing area, 250 sq ft; gross weight, 4,000 lb; wing loading, 16 lb/sq ft; max. speed, 165 m.p.h.; cruising speed, 145 m.p.h.; range 535 miles; climb to 5,000ft, 6.25 min; service ceiling, 17,000ft. (N.B.—Performance figures apply to the version with Cheetah V.)

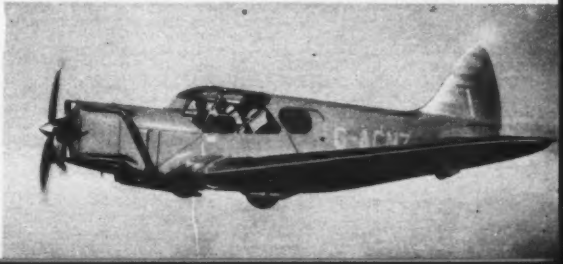
The Ferry, first flown in 1932. Powered with three de Havilland Gipsy engines, it was capable of carrying ten fare-paying passengers for a power expenditure of 36 h.p. per capita.
"Flight" photograph

Two versions of the Courier at Hanworth on the occasion of a demonstration in December, 1933. Nearest the camera is the Cheetah-engined "Colonial" model with a Lynx-powered machine beyond.
"Flight" photograph

The Rapier-Courier, built for A.V-M. A. E. Borton, a Napier director.
"Flight" photograph

Courier (Rapier)

THIS was not a separate Airspeed type, but a direct modification of the Courier to take the 16-cylinder Napier Rapier air-cooled engine, of H formation. The installation was neatly effected, the exhaust pipes being countersunk into the cowling. In its heat prior to the King's Cup Race of 1934 the Rapier-Courier, flown by A.V-M. A. E. Borton, a director of the Napier company, averaged 166 m.p.h.



An Envoy supplied to Czechoslovakia. This version was powered with Walter Castor II engines. During 1935-36 four were delivered there.

An Envoy for domestic use (actually the prototype) with Wolseley engines. Envoys were among the best-looking machines of their day.

AIRSPEED TYPES . . .

Envoy

THIS twin-engined light transport was built in three main variants. The Series I was the original unflapped machine with Wolseley A.R.9, Aries Mk. III, Scorpio, or Armstrong Siddeley Lynx IVC engines. Design changes in the Series II included the fitting of flaps and an increase in tailplane area. The Series III had an entirely new wing structure, and a tailplane of even greater area. Alternative engines in the Series II and III were Cheetah IXs, Walter Castor IIs, Wright Whirlwinds, or Gnôme-Rhône Titans.

The wing of the Series III Envoy had two box-spars with spruce flanges, plywood webs and plywood covering. An all-wood semi-monocoque structure, the fuselage had a plywood skin and internal members of spruce. The cantilever fin was integral with the fuselage and was fabric-covered; the tailplane, similar in construction to the wing, was adjustable over a range of plus or minus 4 deg. As on the Courier, the undercarriage was of the Airspeed-patented "Retractor" type, with Dunlop wheels and brakes, and Vickers oleo-pneumatic shock-absorbers, with 9in travel.

The engines had Townend, N.A.C.A. or Avro-type cowling rings. There was an aluminium fuel tank in the centre-section on each side of the fuselage, held against wooden formers between the spars by steel straps. Extra tanks, of 30 gallons capacity, could be fitted in the outer wings if required. An oil tank for each engine was housed in the leading edge, so that hot oil was cooled by having to pass closely in contact with the leading-edge skin.

The pilot sat in a separate compartment, with access from the cabin. Seats could be provided for up to eight passengers and various layouts were possible.

Span, 52ft 4in; length, 34ft 6in; wing area, 339 sq ft; weight empty (including normal equipment), 4,341 lb; all-up weight, 6,600 lb; max. speed at 7,300ft, 203 m.p.h.; cruising speed at 10,000 ft, 170 m.p.h.; service ceiling, 22,000ft; normal cruising range, 620 miles. (N.B.—Performance figures apply to the Envoy Series III with Cheetah IX engines.)

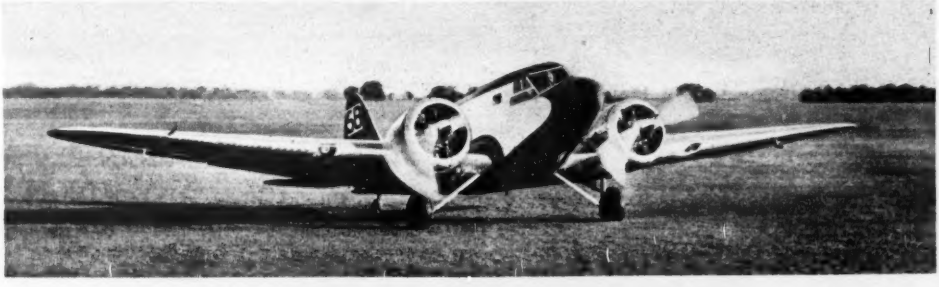
Convertible Envoy

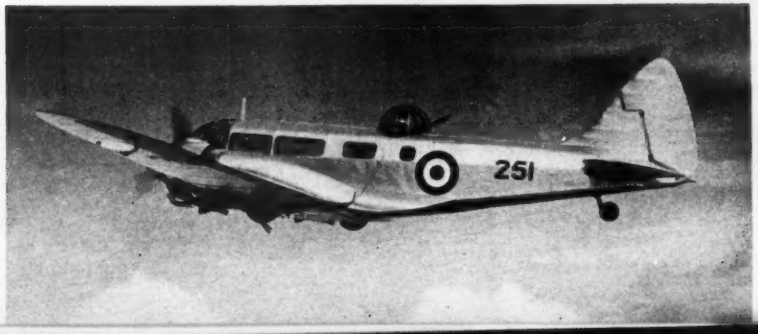
SEVEN Envoys supplied to the Government of the Union of South Africa in 1936 could be converted from civil to military machines by four men in four hours. Four were intended for use by South African Airways and three by the S.A.A.F. Armstrong Siddeley Cheetah IX engines were standardized, though two Convertible Envoys supplied to Czechoslovakia (additional to two "plain" Envoys) had Walter Castor IIs. The civil version accommodated pilot and six passengers, with a lavatory at the rear of the cabin. Conversion to a light bomber or reconnaissance aircraft entailed removal of all seats with the exception of one, which remained for the navigator. The lavatory door was removed and the section of roof above was replaced by a special section incorporating an Armstrong Whitworth manually operated gun turret. Bomb carriers were fitted to lugs beneath the fuselage, and a fixed rifle-calibre gun was mounted on the starboard side of the fuselage nose. The military crew consisted of pilot, navigator, wireless operator and rear gunner. Marconi radio, incorporating a homing attachment, was installed, and in the military version the fixed aerial could be discarded to allow the rear gunner a clear field of fire.

Viceroy

DIRECTLY developed from the Envoy, the Viceroy was specially prepared for the London-Melbourne Race in 1934. Two Armstrong Siddeley Cheetah VI supercharged engines, delivering 315 h.p. at 7,000ft, were installed, and a 270-gallon tank was fitted in the fuselage. The crew numbered two only (there was a bed for the man off duty), but for commercial purposes provision could be made for six to eight passengers. The cabin was slightly narrower than that of the Envoy, and the undercarriage was strengthened to allow operation at an all-up weight of 6,300 lb.

Performance figures: max. speed at 7,000ft, 210 m.p.h.; cruising speed, 190 m.p.h.; stalling speed, 72 m.p.h.; rate of climb at sea level, 1,000ft/min.; range, 1,400 miles approx.

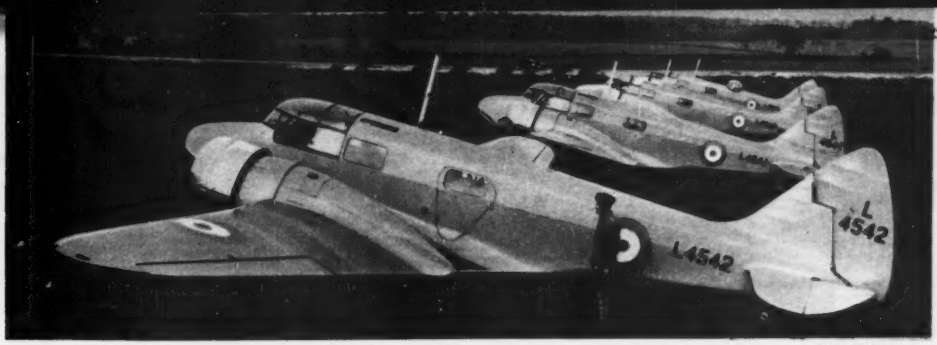




(Above) The Viceroy, with two Armstrong Siddeley supercharged Cheetah engines: a development of the Envoy for the London-Melbourne race of 1934.

"Flight" photograph

(Left) The Cheetah-engined Convertible Envoy in its military form—one of seven supplied to the Government of South Africa.



"Flight" photograph

An early batch of Cheetah-engined Oxford trainers. It will be noted that the most distant machine has a dorsal gun turret. In all, 8,751 Oxfords of various marks were built, 4,961 of them by Airspeed. Under reverse Lease/Lend Oxfords were used by the U.S.A.F. in Gt. Britain.

Oxford

ONE of the world's most famous training aircraft, the Oxford, was a development of the Envoy, to meet Specification T.23/26. Thousands of Oxfords served throughout the war, not only in the United Kingdom but in Canada, Southern Rhodesia, Australia, New Zealand and the Middle East. The type is still widely employed and its roominess has led to adaptation for transport, ambulance and communication flying.

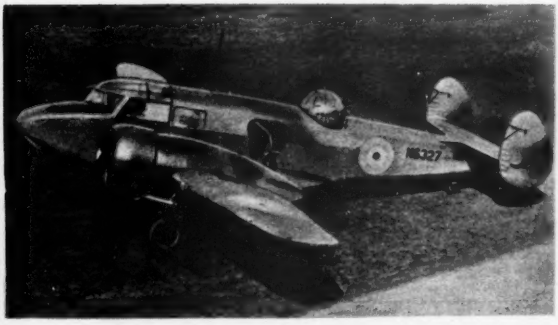
The Oxford I was powered with two Armstrong Siddeley Cheetah IX or X engines (the former having Fairey-Reed metal airscrews and the latter wooden airscrews), and was characterized by a gun turret amidships. Its primary duties were defined as training in bombing and gunnery. Except for the deletion of the turret, and in having equipment to fit it for navigation and radio training, the Oxford II was similar. Higher performance was conferred on the Oxford III by the installation of Cheetah XV engines, driving Rotol constant-speed airscrews. This mark was likewise a navigation and radio trainer. The Oxford IV was an experimental machine for testing D.H. Gipsy Queen IV supercharged engines. Another power plant change came with the Mk V, which had two Pratt and Whitney Wasp Junior R-985-AN6 radial engines driving Hamilton Standard two-blade variable-pitch airscrews. Like the Mks II and III, this was a radio and navigation trainer.

The fuselage of the Oxford is a typical Airspeed semi-monocoque structure, with spruce longerons and stiffeners beneath the plywood covering. The joint between the front and rear sections is made at the rear bulkhead; the forward bulkhead is specially reinforced to withstand the shock in the event of a turnover on landing. A stressed-skin ply-covered structure, with spars having spruce flanges and three-ply webs, the wing is in three parts, to facilitate transport. Split flaps extend from aileron to aileron.

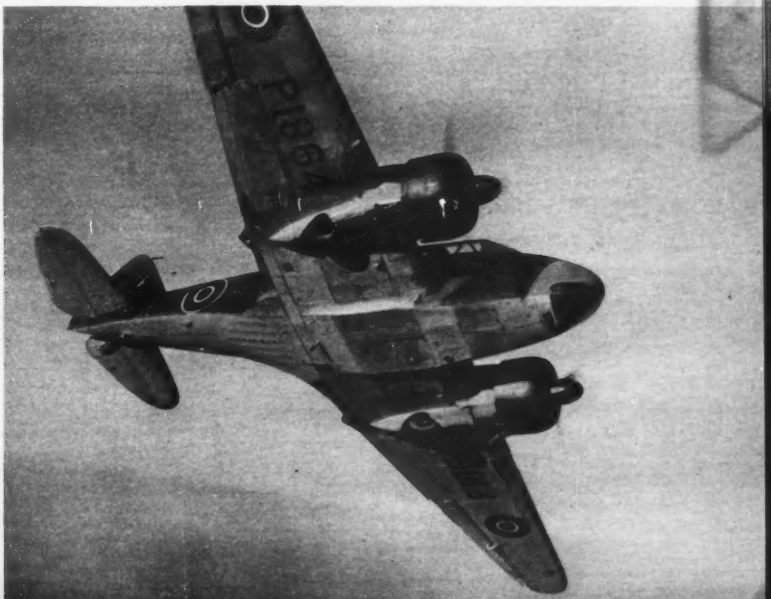
The crew does not normally exceed three, but positions are provided for pilot, navigator or second pilot, bomb-aimer, wireless operator, rear gunner and camera operator. When dual control is not required, one set of controls is removed and space for a prone bombing position becomes available. The navigator occupies the second pilot's seat, which is pushed back in line with the chart table, and the wireless operator has a seat on the rear spar, facing aft.

The gun turret is of manually operated Armstrong Whitworth type, carrying a single Lewis gun, and sixteen 11½lb practice bombs can be carried internally.

Span, 53ft 4in; length, 34ft 6in; height, 11ft 1in. Weights and performances (with Pratt and Whitney Wasp Junior engines): weight empty, with fixed military equipment, 5,670 lb; all-up weight, 8,000 lb; max. speed, 202 m.p.h. at 4,100ft; rate of climb at sea level, 2,000ft/min; climb to 10,000ft, 6 min; service ceiling, 21,000ft.



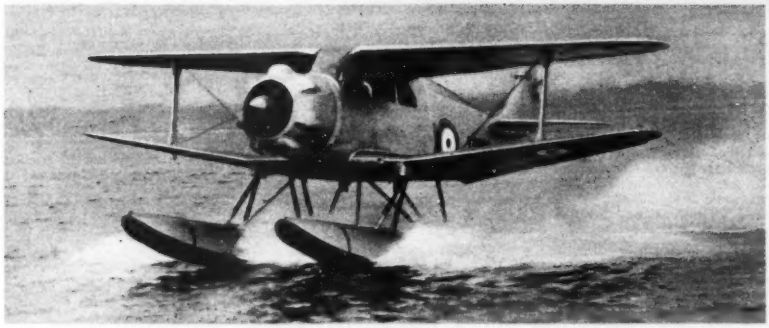
Above is what is believed to be the only photograph extant of an Oxford fitted experimentally with twin fins and rudders and high-set tailplane.



The Oxford V navigation and radio trainer, with Pratt and Whitney Wasp Junior engines, driving Hamilton Standard variable-pitch airscrews.

"Flight" photograph

AIRSPEED TYPES . . .



Landplane prototype of the Queen Wasp radio-controlled target aircraft, as it appeared among the new and experimental types at the Royal Air Force Display in 1937.
"Flight" photograph

A Queen Wasp float-plane (Armstrong Siddeley Cheetah) on test. Catapult trials were made from H.M.S. Pegasus by F/L. Colman.
"Flight" photograph

Queen Wasp

THOUGH provision was made for a pilot when the aircraft was engaged on experimental flying, the Queen Wasp was primarily a radio-controlled target for aerial gunnery. The folding, tapered, biplane wings were two-spar, ply-covered, structures. Slotted flaps were fitted on the upper wings and, in addition, the ailerons on the lower wings were used as flaps, the differential aileron action being preserved at all flap angles. A two-axes automatic pilot was used, and when this was engaged the ailerons were locked. The fuselage was in three sections: the front portion was of welded steel tubes; the centre portion (including the wing centre-sections) had two main bulkheads of spruce and compressed wood, plywood-covered; and the rear part was a semi-monocoque plywood-covered structure. For land use two fixed cantilever undercarriage units were fitted on the bottom centre-section front spar. As a seaplane the Queen Wasp had two single-step metal floats, mounted independently.

Span, 31ft; width folded, 12ft; length, 29ft; height, 13ft.

The Airspeed Fleet Shadower (above) was a deck-landing type, with four Pobjoy Niagaras, designed to Specification S.23/37. Below, the machine is seen with wings folded for aircraft-carrier stowage.

AS-39 Fleet Shadower

BOTH in respect of technical features and intended operational employment this type was of exceptional interest. It was designed to operate from aircraft carriers and to shadow enemy fleets by night. The specification (S.23/37) demanded very slow cruising speeds, long duration, and a wide field of view for the pilot and observer. The high wing was of wooden construction and was fitted with leading-edge slots and slotted flaps. Each wing, complete with its two Pobjoy engines and one fuel tank, folded from the root. Essentially, the structure comprised two spruce-and-plywood box spars, former ribs and plywood covering. The sections between the spars were watertight to provide buoyancy in the event of a forced alighting. The fuselage was of all-metal, stressed-skin monocoque construction, with the exceptions of the forward compartment for the observer (which was detachable) and the complete tail unit. Special long-travel shock-absorbers were embodied in the fixed, divided undercarriage. The crew of three consisted of pilot, observer and radio operator.

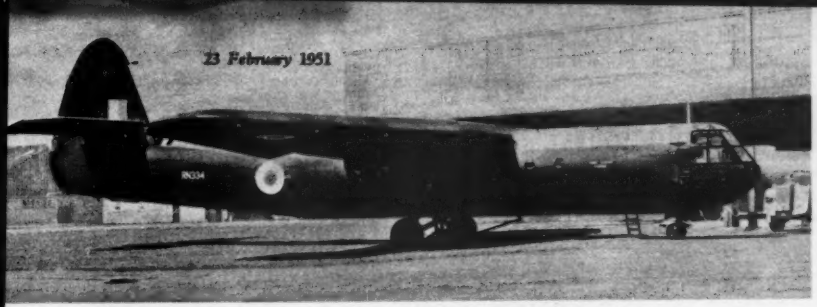
Span, 53ft 4in; length, 40ft; height, 10ft 5in; folded width, 18ft; weight empty (with fixed military equipment), 4,592 lb; all-up weight, 6,935 lb; max. speed, 126 m.p.h. at 5,000ft; cruising speed at 5,000ft, 113 m.p.h.; full-throttle stalling speed at sea level, 33 m.p.h.; rate of climb at sea level, 865ft/min; rate of climb at 5,000ft, 630ft/min; climb to 10,000ft, 18 min; service ceiling, 14,700ft; absolute ceiling, 16,700ft.

AS-45 Advanced Trainer

BUILT to Specification T.4/39, this trainer, two prototypes of which were completed and flown, was powered with a Bristol Mercury VIII nine-cylinder supercharged engine, driving a de Havilland or Rotol constant-speed airscrew. The crew of two had tandem enclosed cockpits, with full dual control. There were two fuel tanks, one in each wing, with a total capacity of 130 gallons. Construction followed normal Airspeed practice.

Span, 42ft; length, 36ft 1in; height (tail down), 11ft 6in; wing area, 290 sq ft; max. economical cruising speed at 16,000ft, 237 m.p.h.; climb to 15,000ft, 12½ min; range, 680 miles; service ceiling, 24,800ft.

The AS-45 trainer (Bristol Mercury VIII), to Specification T.4/39.



A Horsa glider, of the type which did such splendid work in some of the war's most critical airborne actions. A total of 3,655 Horsas was built by Airspeed and sub-contractors.

Horsa

ONE of the most successful troop- and freight-carrying gliders used by any nation, the Horsa first went into action in the invasion of Sicily. Later it made a name for itself in the Normandy landings, the assault on Arnhem and the invasion of Southern France. There were two versions: the Horsa I was a troop-carrier, with towing-cable attachments at the roots of the main undercarriage legs, and the Mk II (still in service) has a hinged nose to permit freight, guns, vehicles, etc., to be shipped and unshipped. The Mk II also differs in having twin nosewheels and a towing-cable attachment incorporated in the nosewheel-strut.

The high wing is in three sections and is of all-wood construction. Pneumatically operated split trailing-edge flaps are fitted between the ailerons and fuselage. The fuselage is a wooden semi-monocoque structure, of circular section, in the extreme nose of which is the pilot's compartment, with side-by-side seats and dual controls. The main compartment accommodates fifteen fully armed troops on benches along the sides. In addition to internally stowed loads, supply containers can be carried on special fittings under the centre-section of the wing —three containers on each side of the fuselage.

Span, 88ft; length, 67ft; height, 19ft 6in; wing area, 1,104 sq ft; weight empty, 8,370lb; all-up weight, 15,500lb.

Ambassador

THE development of the Ambassador and various operational aspects having been discussed elsewhere in this supplement, these notes are confined to a brief structural description. Dimensions, weights, performances, etc., are tabulated on page 230.

The laminar-flow, high-aspect-ratio wing consists of a centre-section, carrying the engine nacelles; detachable outer wings, attached by span-wise bolts; and detachable tips. There are two spars, built-up braced ribs, and closely spaced Z-section extruded-alloy stringers. The skin is of heavy gauge and thickness and stringer-pitching have been graded along the span, so that the skin, with its stiffeners, takes some 90 per cent of the bending loads at the root end of the outer panels.

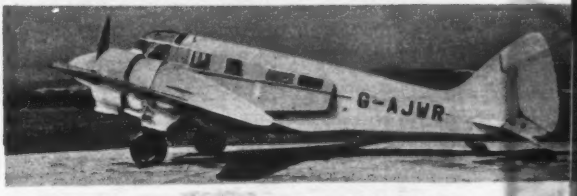
In cross-section the fuselage is basically two intersecting circles. The structure embodies vertical frames and bulkheads, longitudinal stringers of double-angle-section and flush-riveted Alclad skin. Of Airspeed-Dowty design, the undercarriage embodies two main units, each having twin 37-in wheels, and a steerable nose unit with twin 26.6-in wheels. The undercarriage is raised hydraulically and lowered by gravity and air drag.

There is an integral 500-gal fuel tank in each outer wing, and provision is made for two additional bag tanks, each holding 300 gallons, in the centre-section.

Consul

THE Consul is a civil conversion of the Oxford and has been delivered to commercial and military operators in various forms. These include the standard 5/6-passenger model, with a crew of two; an ambulance, carrying two stretcher cases and one or two sitting cases; and the "Convertible" Consul, which has the same large door as the ambulance but is adaptable for freight-carrying or communication work in addition to ambulance flying. Another variant is the Consul "Executive," with four passenger seats, a toilet and extensive luggage accommodation.

The military Consul has provision for four 25-lb rocket projectiles, beneath each wing, and two fixed 0.303-in guns.



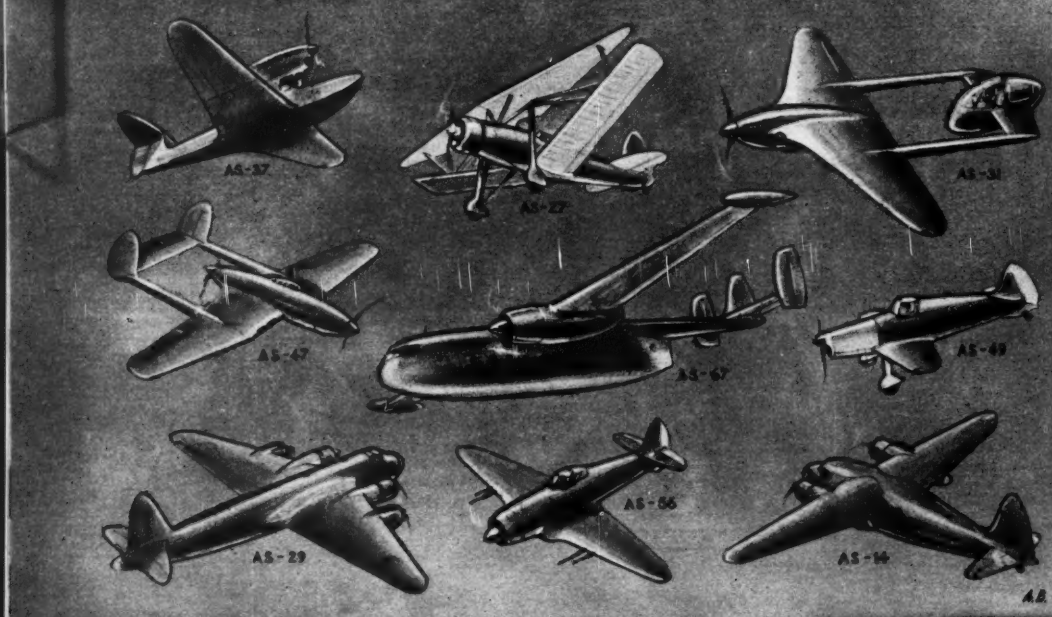
The uppermost of the Consuls above is a civil "Convertible" version. Below it is a military Consul, supplied to Burma; this machine has provision for eight rocket projectiles and two fixed machine guns.

The Airspeed Ambassador medium-stage airliner (two Bristol Centaurus eighteen-cylinder sleeve-valve engines), outstanding among modern transport aircraft for its grace, comfort and operational efficiency.

AIRSPEED TYPE DESIGNATIONS

(In each case the type number carries the prefix AS-)

Type No.	Name and Identifying Characteristics	First Flight
1	Tern. High-performance cantilever sailplane	1931
2	Glider project	
3	Two-seater monoplane project	
4	Ferry. Ten-seat biplane (one D.H. Gipsy III and two D.H. Gipsy IIs)	1932
5	Courier. Five/six-seater monoplane (Armstrong Siddeley Lynx IVc; could also have Wasp Junior, Whirlwind or Cheetah)	1933
5A	Courier I. British model (Lynx IVc)	1933
5B	Courier II. Overseas model (Cheetah V)	1933
5C	Courier. Experimental model with Napier Rapier	1934
5J	Courier (Armstrong Siddeley Cheetah IX)	1935
6	Envoy. Six/eight-seater monoplane (two Wolseley A.R.9s)	1934
6A	Envoy. Series I (two Armstrong Siddeley Lynx IVcs)	1934
6B	Envoy. Series I. Seaplane project (two Wolseley A.R.9s)	
6C	Envoy. Series I. Seaplane project (two Armstrong Siddeley Lynx IVcs)	
6	Envoy. Series II. Flaps and increased tailplane area. Suffix "D" denotes two Wright Whirlwinds; "E" two Walter Castor IIs; "F" photographic survey project; "G" two Wolseley Scorpio Is	1935
6	Envoy. Series III. Flaps, ply-covered wing and tailplane with further increased area. Suffix "E" denotes two Walter Castor IIs; "H," two Wolseley Aries IIIs; "J," two Armstrong Siddeley Cheetah IXs; "K," two Wolseley Scorpio IIs	1936
6Jm	Envoy. Series III. Convertible for military use (Cheetah IXs)	1936
6Jc	Envoy. Series III. Civil version of above	1936
7	Military Envoy project	
7J	Military Envoy project (Cheetah VIs)	
7K	Military Envoy project (Scorpio IIs)	
8	Viceroy. Special racing model of Envoy (two Cheetah VIs)	1934
9	Interceptor fighter project. Eight-gun, low-wing, strut-braced monoplane. Napier Dagger, or engine of similar power	
10	Oxford I. General-purpose advanced trainer to Spec. T.23/36 (two Cheetah IXs)	1937
10	Oxford II. Pilot-training only	1938
10	Oxford Ambulance. (two Cheetah IXs)	1938
10	Oxford II. Experimental machine with twin fins and rudders used for spinning tests (two Cheetah IXs)	1939
10	Oxford II. Experimental machine with Rotol constant-speed airscrews (two Cheetah XVs)	1939
10	Oxford II. Experimental MacLaren undercarriage (two Armstrong Siddeley Cheetah Xs)	1939
10	Oxford II. Experimental aircraft with two D.H. Gipsy Queen IVs	1940
10	Oxford I. Experimental undercarriage retraction by Metropolitan-Vickers	1943
10	Oxford III. One prototype (P1864) with Cheetah XV engines and additional equipment	1941
10	Oxford IV. Projected pilot-training version of Oxford III	
11	Courier. Projected all-metal version for Canadian market	
12	Four-engined aircraft project	
13	Type number not used	
14	Twin-engined, sixteen-passenger transport project (known as Ambassador)	
15	Projected day and night bomber	
15A	Projected passenger version of AS-15	
16	Fokker F.XXII. Four-engined transport.	
17	Fokker D.XVII. Single-seat fighter (Rolls-Royce Kestrel)	
18	Variant of AS-17	
19	Fokker D.XIX. Single-seat fighter (Rolls-Royce Kestrel)	
20	Fokker F.XXXVI. Transport	
21	Fokker D.XX. Single-seat fighter	
22	Fokker C.X. Two-seat fighter	
23A	Fokker C.X.W. Floatplane	
23	Douglas DC-2	
24	Long-range [illegible] carrying [illegible]	
25	Number not allotted	
26	Car-carrying biplane project. (Fuselage similar to Cunliffe Owen's Burnelli project)	
27	Special defence-aircraft project. Irving biplane and high-wing monoplane versions	
28	Twin-engine passenger transport project	
29	Bomber to Specification B.1/35 (four Bristol Aquilas or four Rolls-Royce Goshawks)	
30	Queen Wasp. Radio-controlled gunnery target. To Spec. 32/35 (Armstrong Siddeley Cheetah IX)	1937
31	Projected fighter. Two booms, cabin on tail, eight guns. To Spec. F.35/35	
32	Projected airliner with four Bristol Aquila or Libra engines	
33	Projected airliner with four Bristol Aquila or Libra engines. Twenty-four seater	
34	Projected 12/15-seater airliner (four Armstrong Siddeley Cheetah IX engines)	
34A	Projected 12/15-seater airliner (four Wolseley Scorpion II Engines)	
35	Projected 12/15-seater airliner (four de Havilland Gipsy engines)	
36	Two-seater trainer project to spec. T.1/37	
37	Radio-controlled target flying-boat project to Spec. Q.8/37 (D. H. Gipsy Six Series II)	
38	Communications aircraft project. Modification of AS-30 Queen Wasp	
39	Fleet Shadower. Carrier-borne observation aircraft to Spec. S.23/37 (four Pobjoy Niagara Vs)	1939
40	Oxford civil conversion for radio research. Two built	1938
41	Experimental Oxford with two Alvis Leonides. Installation by Miles Aircraft Ltd.	1946
42	Oxford I to Spec. T.39/37 for New Zealand	1938
43	Survey version of AS-42	1938
44	Projected Oxford replacement	
45	Single-engine trainer to Specification T.4/39 (Bristol Mercury VIII)	1940
46	Oxford V ("winterized.") Two Pratt and Whitney Wasp Juniors. Converted Oxfords with Hamilton c.s. airscrews, but no cabin heating or provision for oil warming, were designated Oxford V Series II. The Canadian version was Oxford V Series I	1942
47	High speed twin-boom bomber project with two Napier Sabres or two Rolls-Royce Merlins (one tractor, one pusher)	
48	Projected single-seat night fighter with Napier Sabre engine. Six 20 mm guns	
49	Projected single-seater fighter/trainer to Spec. T.24/40, with D.H. Gipsy Six engine	
50	Type number allocated to production Queen Wasps to Spec. T.24/40	
51	Horsa I. Troop-carrying glider to Spec. X.26/40	1941
52	Horsa I. Bomb-carrying project to Spec. X.3/41	1941
53	Horsa I project for vehicle transport	
54	Projected two-seater training glider to Spec. TX.3/43	
55	Cobham high-wing freighter project with either two Bristol Hercules XIVs, four Bristol Taurus XXs, four Rolls-Royce Merlin XXIs or two Bristol Centaurus engines	
56	Projected single-seater fighter with Napier Sabre VI engine and four 20 mm guns	
57	Ambassador. Projected version with two Bristol Hercules engines	
57	Ambassador I. 40/50-seater airliner to Spec. C.25/43 (two Bristol Centaurus 631s)	1947
57	Ambassador I. Forty/fifty-seater airliner to Spec. C.25/43 (two Bristol Centaurus 661s) (Production model)	1950
58	Horsa II. Vehicle transport glider with opening nose (twin nose wheels)	1943
59	Ambassador II project for two Bristol Proteus or Bristol Theseus, four Napier Naiads, or four Rolls-Royce Darts	
60	Ayrshire. Projected military transport version of Ambassador to Spec. C.13/45 (two Bristol Centaurus 130s)	
61	Dakota I conversion	
62	Dakota II conversion	
63	Dakota III conversion	
64	Ambassador project for R.A.F. to Spec. C.26/43	
65	Consul. Civil version of Oxford (two Armstrong Siddeley Cheetah Xs	1946
66	Projected civil freighter development of Ambassador	
67	Projected civil freighter development of Ambassador	



BACKGROUND TO THE AMBASSADOR

Some Thoughts on Getting an Airliner off the Drawing-board and into the Air

By Major HEREWARD de HAVILLAND, D.S.O.

THOSE of us who were in the industry when aircraft could be designed, built and put into production within twelve months of the initial conception may perhaps be forgiven if, momentarily, we wonder what has changed during the past twenty years; but then we remember the performance and operational requirements of to-day's aircraft and compare them with those of two decades ago and realize that, for better or worse, we are dealing with a very different and more complex set of conditions.

It is not enough to make the obvious statement that speed, range and service-life requirements have gradually increased to three or more times the figures accepted in those days; the point is that these increases—coupled with the stricter standards of safety and the effect of the equipment which has to be carried to satisfy these standards—have brought in their train a host of new problems: so much so that the design and development man-hour total per pound of aircraft weight has increased out of all proportion.

As many people know, intensive effort on the production-type Ambassador—a development of the initial aircraft ordered by the Government during the later war years—started in the early part of 1948. Although the superficial appearance remains the same, this production Ambassador is really a very different aircraft and an outline of some of the work done in the intervening three years may help to give those readers who are not themselves in the industry some idea of what is involved in the production of a modern civil aircraft.

Starting with the broad requirements, the developed Ambassador for British European Airways and other airline operators was planned with a payload considerably higher than that originally envisaged. This, of course, involved a higher all-up weight which had already been agreed when investigations had been made of the possible performance of the Ayrshire, a projected military version of the Ambassador. In order to comply with the stringent engine-failure requirements of the post-war P.I.C.A.O., a higher take-off power was then needed; and this, coupled with the decision to take full advantage of pressurization by cruising at higher levels, necessitated the development of new power-plants with two-speed blowers.

In its train, the new all-up weight brought minor modifications to the design of the undercarriage, a certain amount of stiffening of the original structure, increased braking power, and, indirectly, such changes as the introduction of automatic airscrew-pitch coarsening—to deal, in this instance, with the difficult case of engine failure in which climb-away had to be possible during take-off without further action by the pilot. Pressurization for operation at 20,000ft also introduced many new problems, both in airframe and power-plant. De-icing, apart from the need to develop and test a thermal system from little-known first principles, involved a re-design of the electrical system in order to provide sufficient power for the cyclic heating of the airscrew blades.

Meanwhile, work had to proceed, in parallel with production, on the construction of test specimens, including full-span wings, complete fuselages, an empennage, and a variety of castings, forgings and other items. Many of these specimens were tested in our own research laboratory and test house: others, which were too big, were sent elsewhere. The full-scale fuselage pressure test was carried out under water in Portsmouth dockyard, there being no test tank in England large enough to take it.

The 115ft wing was sent to the R.A.E., Farnborough, and a second full-scale fuselage went there also for torsion and bend-

Milestone in 1947: towing the first Ambassador prototype from the Christchurch experimental shop to the flight shed.

BACKGROUND TO THE AMBASSADOR

ing tests. The wing, of very advanced design, failed to pass initial tests, and this was indeed a grave set-back. Much midnight oil was burned and the final test was completely successful, showing a reserve strength slightly greater than that required. Moreover, the nature of the ultimate failure proved that the quality of workmanship was of an extremely high order.

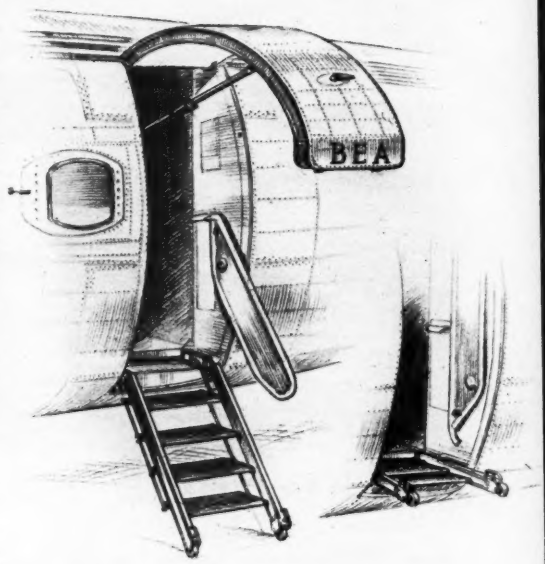
It might be as well to note here, for the benefit of non-technical readers—and without in any way intending to excuse cases of structural weakness—that in aircraft design the saving of weight is all-important. It is easier, and usually a good deal cheaper, to make things too strong and, therefore, too heavy. What is difficult—and costly—is to make them *just strong enough*.

This test programme, in itself, was a major job of work, necessitating rigs for applying torsion, bending, tension, fatigue loading, and pressure, as the case might be; and when it is remembered that many new ancillary items were being subjected to similar development and test by their respective manufacturers, the magnitude of the task can be imagined. The work on all these additional items—brakes, blowers, electrical equipment, combustion heaters, hydraulic power-packs, actuators and so on—had to be undertaken in parallel by the various suppliers, and the final production units planned for delivery to suit the production schedule of the aircraft themselves. Not unnaturally, there have been delays in our own organization and elsewhere.

It would obviously be impossible to describe in detail, in these notes, the test and development progress since 1948, so we will simply take one or two examples.

First in importance has been the work on the new civil-rated Bristol Centaurus 661 power-plants which are now in series production. It was agreed in the earlier days that Bristols would produce the bare engines and exhaust systems and that Airspeed would develop and produce each power-plant as a whole. Within the short period of two years from the start of work this entirely new version of the Centaurus had passed its civil type-test and Airspeed were flying an experimental power-plant in the port nacelle of that hard-used work-horse, the first Ambassador prototype. Incidentally, the strangely asymmetric appearance of this aircraft, so engined, was further increased by the fact that the port nacelle also carried the first production-type undercarriage; and the remainder of the prototype was, from time to time, festooned with airscrew strain-gauge wires, thermo-couple strips and other devices concerned in the tests of the thermal de-icing system.

This 661 engine is no ordinary Centaurus with another mark number. It is entirely new in many particulars, with a re-designed rear cover to take the two-speed blower and auxiliaries; copper cylinder heads; and a baffle system which was the result of a new conception in the way of individual cylinder cooling. The power-plant is, too, in many ways, a new departure, with petal-type cowlings, new cooling and induction intake systems and wide-chord gills. It was designed as a detachable and interchangeable unit, carrying its own oil tank and with the control, electrical and fluid connections arranged for rapid disconnection and reconnection. Of course there were troubles—what new engine or power-plant has been without them?—and a great deal of flying was done while low-speed cooling tests were being completed with pressure readings from a score of points in the nacelle. Two power-plants are to complete a 250-hour A.R.B. endurance trial in the first production Ambassador.



Practical, efficient and economical though the twin-engine formula is from the airline operator's point of view, it has its problems in meeting engine-failure requirements. Very many hours of flying and many adjustments to the rudder and spring-tab configuration were necessary before an acceptable balance between opposing needs was reached, providing asymmetric control down to, and below, safety speed, and an acceptably light control at cruising speeds. It may be remembered that, at the 1948 Farnborough Show, the Ambassador was taken off and demonstrated entirely on one engine.

Overall, and as might be expected in a civil aircraft developed after six years of war, the design of a very large proportion of the ancillary features of the Ambassador was started, so to speak, from scratch, and we were glad—if often harassed by delays and .et-backs—to be the first firm to incorporate a number of these features in an aircraft. Such things as pressurization, thermal de-icing, steerable nosewheels, disc-type brakes, interchangeable power-plants, braking airscrews, electro-hydraulics and alternators are certainly not very new to us all in 1951, but they were new when Airspeed and the ancillary industries started to work on them.

All this is common experience in the aircraft industry, but it is not generally appreciated in the outside world. The civil aircraft of to-day must be planned four or five years in advance of its commercial introduction, yet its design must be as up to the minute as that of any other aircraft in being—or even on the drawing-board. Furthermore, its size and layout must be such as will appeal to the airline operator of its class at the time when it is due to go into service; and, most important of all, it must be intrinsically capable of continued development, with a structure able to take the higher all-up weights which increased power will certainly permit later in its operational life.

AIRSPEED AMBASSADOR

Dimensions and Areas

Span	115ft
Length	81ft
Height overall	18ft 4in
Wheelbase	24ft 5.6in
Track	27ft 6in
Gross wing area	1,200 sq ft
Mean chord	10ft 5in
Aspect ratio	11

Weights and Loadings

Basic operational weight	35,884 lb
All-up weight	52,000 lb
Max. landing weight	50,000 lb
Disposable load	16,116 lb
Power loading (at 52,000 lb)	10 lb/h.p.
Wing loading (at 52,000 lb)	43.3 lb/sq ft

Power Plants

(Two Bristol Centaurus 661 eighteen-cylinder two-row air-cooled sleeve-valve engines, with two-speed supercharger and Hobson-R.A.E. injector.)

Output ... 2,700 b.h.p. at 2,800 r.p.m. for take-off (2,600 b.h.p. with exhaust system fitted).

Fuel ... 100/130 grade.

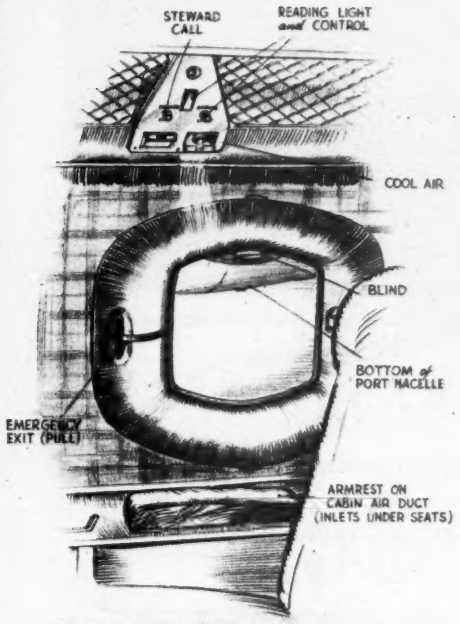
Airscrews

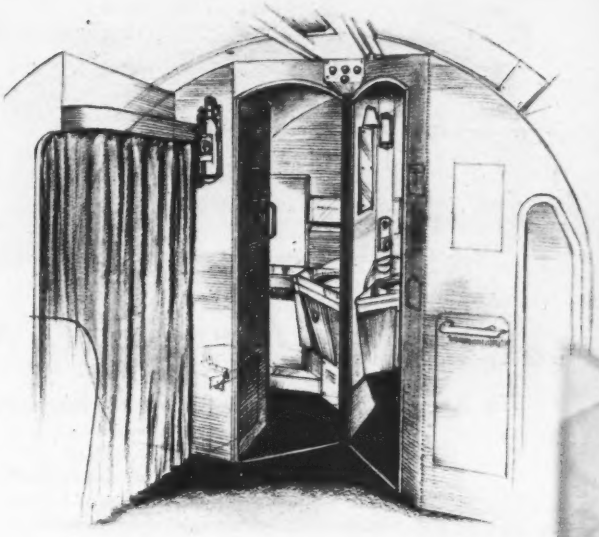
de Havilland 4-blade fully-feathering reversible-pitch, of 16ft diameter.

Performance Summary

(I.C.A.N. Standard Conditions)

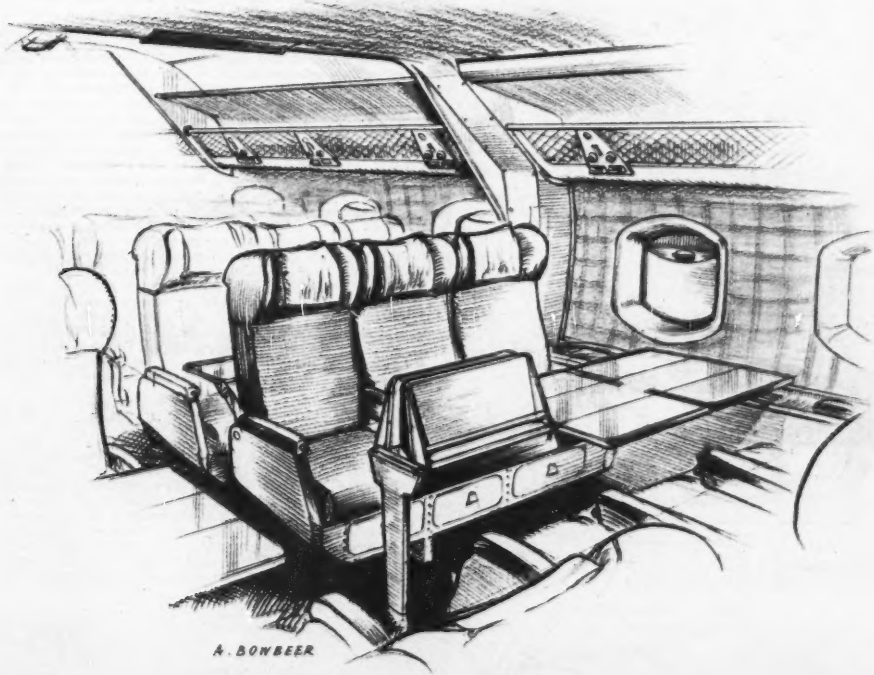
Take-off distance to 50ft (at max. a.u.w.)	1,090 yd
Take-off distance to 50ft (one engine inoperative at max. a.u.w.)	1,530 yd
Rate of climb after take-off (one engine inoperative at max. a.u.w.)	420ft/min
Continuous climb at 5,000ft (at max. a.u.w.)	1,520ft/min
Continuous climb at 5,000ft (one engine inoperative at max. a.u.w.)	360ft/min
Max. weak-mixture cruising speed at 20,000ft (at 50,000 lb)	300 m.p.h.
Cruising speed at 20,000ft and 60 per cent METO power (at 50,000 lb)	279 m.p.h.
Consumption	1,535 a.m.p.g.
Cruising speed at 20,000ft and 45 per cent METO power (at 50,000 lb)	242 m.p.h.
Consumption	1,775 a.m.p.g.
Max. payload	11,650 lb
Ultimate range (no allowances) with max. payload, cruising at 280 m.p.h.	720 st. miles
Ultimate range (no allowances) with max. payload, cruising at 220 m.p.h.	900 st. miles
Ultimate range (no allowances) with full tanks, cruising at 280 m.p.h.	1,560 st. miles
Ultimate range (no allowances) with full tanks, cruising at 220 m.p.h.	1,950 st. miles
Payload with full tanks	7,900 lb
Landing distance from 50ft (at 50,000 lb)	855 yd

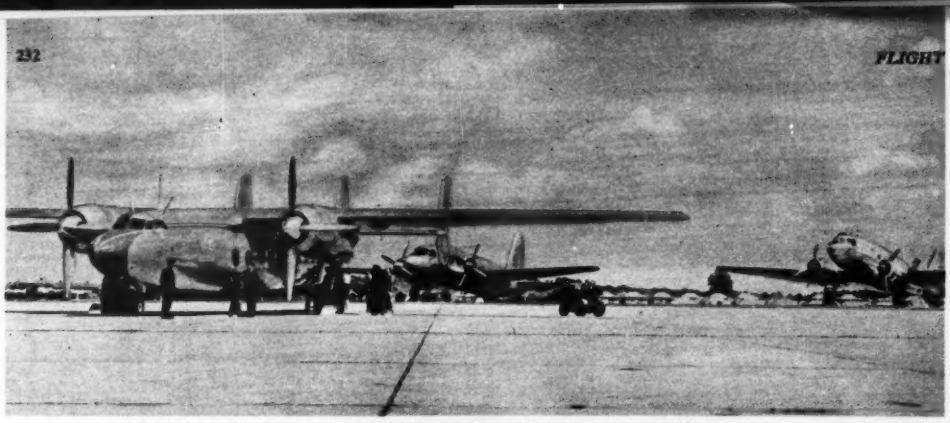




ELIZABETHAN INTERIOR

These "Flight" copyright studies illustrate a few items planned for the comfort and convenience of passengers in the "Elizabethan"-class Ambassador airliners of British European Airways. On the preceding page are the rectractable steps and handrail ; at top left, one of the six window-type emergency exits ; top right, the two toilets and coat-space ; and below, seats in the "Pullman" compartment, with their wide folding tables. The arm-rests can be completely folded.





Symbolic, in that the Ambassador "steals the picture" from the stalwart Viking and Dakota, is this scene on the tarmac at Northolt.

B.E.A.'s ELIZABETHANS

The Ambassador Fleet : Versatility in Passenger-accommodation : Economic Promise

By PETER G. MASEFIELD, M.A, F.R.Ae.S., M.Inst.T., Chief Executive of B.E.A.

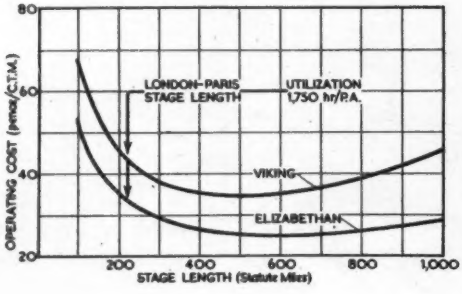
AIRSPEED Ambassadors of the British European Airways "Elizabethan" class, wearing B.E.A. colours, will be in service on European routes this summer. B.E.A.'s first production Elizabethan, G-AMAD, *Sir Francis Drake* ("Able Dog" for Admiral Drake—a true sea-dog), flew for the first time on January 12th, 1951. After preliminary tests it is to be devoted initially to vital de-icing trials so that an unrestricted-category C. of A. can be gained at the earliest possible date.

The second production Ambassador is therefore likely to be the first Elizabethan in B.E.A. operation and thus is to be designated the flagship of the new fleet. To be known as R.M.A. *Elizabethan*, it will wear the appropriate registration letters G-ALZN in conformity with B.E.A.'s policy not only of naming its aircraft individually but also, where possible, of fitting the registration letters to the name.

The new aircraft, designed specifically for medium-stage operations at a relatively high cruising speed and at a low specific operating cost, will give a New Look, operationally and financially, to many of B.E.A.'s routes. Careful planning will, of course, be needed to achieve the best results from the new aircraft and a gradual process of "working up" is inevitable. The full impact of the Elizabethan class on European services cannot be expected until the Summer of 1953.

The Elizabethan, in its B.E.A. form, will have normal accommodation for 47 passengers on routes of high traffic-density. However, the accommodation has been specifically arranged for flexibility and can be varied in B.E.A. service from a layout of 28 luxury passenger-seats with a large forward freight compartment ahead of a movable bulkhead, through 34-passenger and 47-passenger versions to a high-density layout with 49 seats.

Graph illustrating the effect of variations in stage-length on the total operating cost of the B.E.A. Viking and Elizabethan.



All this is achieved by use of three interchangeable sets of specially designed adjustable chairs, each having its own folding table and arm-rests. The B.E.A. "standard" 47-passenger version of the Elizabethan has ten rows of seats, the front two rows being four abreast with a middle gangway, the midships seven rows having three seats on the port side and two on the starboard side, while the after row has pairs of seats again. A complete departure from traditional airline seating is that the front four rows (18 seats) are backward-facing towards a Pullman compartment, in the middle, in which six people on the port side and four on the starboard face each other across wide folding tables. This standard B.E.A. version incorporates all three varieties of seats—the three-abreast set, the high-density two-abreast set (midships), and the low-density, two-abreast set (forward and aft). All these chairs have been specially designed for the Elizabethan in order to offer the best achievable compromise of comfort in a seat which will fit the extremes of human dimensions, from the tall fat man to the short slim woman. Every individual seat is adjustable separately and all have a new type of head-rest for maximum comfort. The three-abreast seats are so arranged that when occupied by only one or two passengers they can be used as a wide lounging settee, the middle arm-rests folding completely into the backs. Special attention has been given also to the provision of the maximum possible leg-room with unobstructed space under the seat in front.

The luxury version of the Elizabethan for longer-haul services can be converted from the standard version in a very short time. It incorporates either ten rows of the wide double seats, offering accommodation for a total of 40 passengers or, alternatively, seven rows of the luxury seats in the after cabin, offering accommodation for 28 passengers, while a movable forward bulkhead converts the front cabin into a freight hold with a capacity of 312 cu ft.

The Elizabethan class is thus one of the most versatile of modern commercial passenger-aircraft.

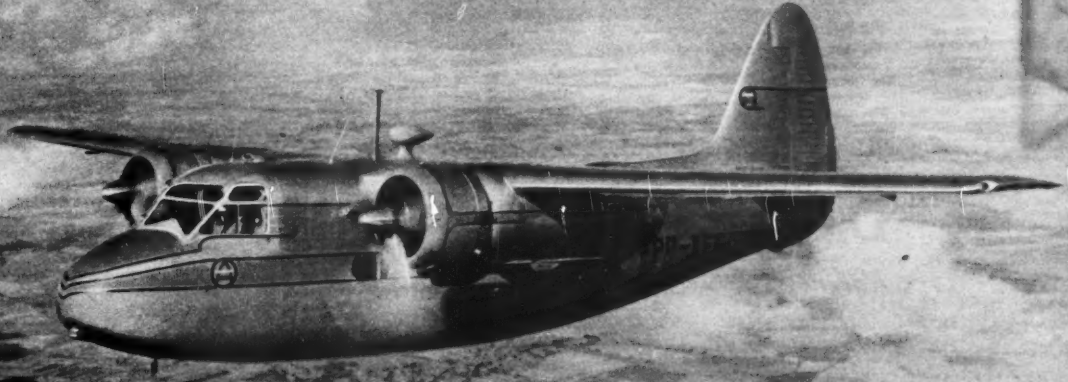
From the passenger's point of view the type has a further advantage over its contemporaries. The high wing makes possible an uninterrupted view from every position in the fuselage, while the large windows (12in by 20in) enable the inboard passengers to see out without difficulty. Some people have suggested that a high-wing aircraft might be at a disadvantage in the event of a wheels-up landing. Experience of three belly-landings with prototype Ambassadors has shown that there is little ground for concern. In no instance has there been damage to the passenger section of the fuselage and on each of the three

The Percival P.56

The "P.56" side-by-side, 2 seat Basic Trainer is built to the requirements of the Royal Air Force. This new trainer follows the successful "Prentice" Basic Trainer, standard training equipment of the R.A.F. and other Air Forces overseas. The "P.56" is the latest development in the Percival tradition as manufacturers of Service training aircraft.

The Percival PRINCE

The "Prince", 8 to 12 passenger Feeder Liner, Naval and Military Crew Trainer, Ambulance and Aerial Survey aircraft is designed especially to operate from tropical and high altitude airfields. With an unusually spacious cabin interior providing for a variety of installations both for civil and military duties, the "Prince" has performance characteristics (particularly on one engine) conforming to the latest International requirements.



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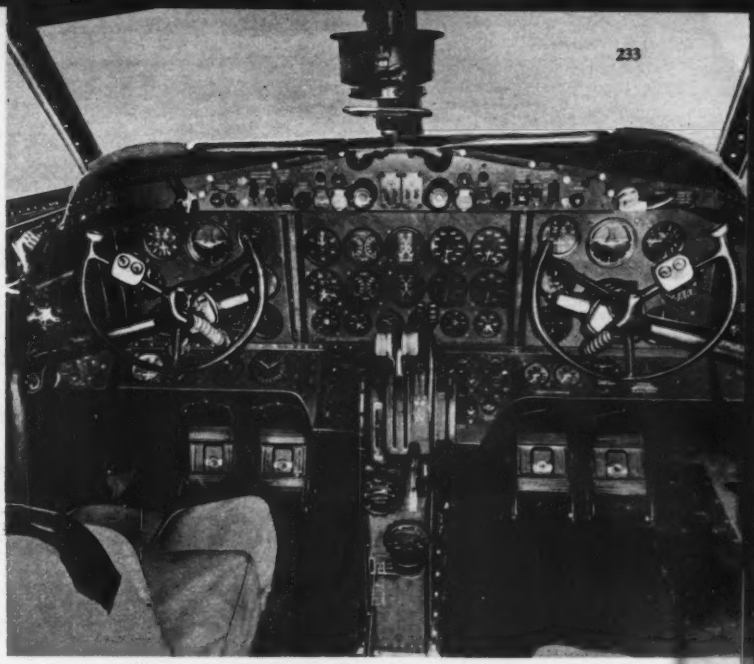


Logical grouping and the elimination of all that is unnecessary has led to a commendably simple and roomy cockpit and, large as it is, the Ambassador can safely be flown solo. Experiences at the controls were described in detail in Flight of October 20th, 1949 (No. 33 of the "In the Air" series). This photograph shows that engine instruments (including two-needle r.p.m. and boost dials) are arranged on the central panel and that a full complement of blind-flying instruments is provided in front of each pilot. Lined up across the top of the three main panels are the emergency controls and indicators, and the buttons and switches for ignition, priming, starting and slow-running cut-off. Carried on the compact central pedestal are levers for power, airscrews and services and also the three "sensed" trimming wheels.

occasions the damage to engines and nacelles has been less than would have occurred to a low-wing type. There seems evidence to suggest that a high-wing layout will usually suffer less than a low-wing type in such circumstances.

Those who have flown in the Ambassador prototypes of the B.E.A. Elizabethans know how favourably they compare with other piston-engine types on the score of noise-level and general vibration. From a flying point of view the Elizabethan has the feel of a "big aircraft" while retaining the comparatively sprightly characteristics of its smaller brethren.

Performance-wise—as our American friends would say—the Elizabethan will give B.E.A. an edge over most of its rivals. Initially, schedules and sector times will be based on a power output of 1,150 b.h.p. per engine (50.7 per cent METO power and 42.6 per cent take-off power), which, at a mean weight of 51,500 lb, pressurized at 20,000ft, offers a true air cruising speed of 259 m.p.h. (225 kt). To maintain schedule against headwinds or in the event of delayed departures, an increase in power of up to 1,300 b.h.p. per engine will be available, making possible an increase of cruising speed up to 274 m.p.h. (238 kt) to maintain punctuality. Later on, as more experience is gained with the Bristol Centaurus 661 engines, these powers may be increased. In the meantime, the relatively low powers selected should ensure reliability while maintaining respectable cruising speeds.

In fact, even at these low initial powers the Elizabethan is nearly as fast as its most modern competitors operated at their highest commercial cruising speeds. Proportionately, power for power, the Elizabethan will be more than 20 m.p.h. faster than the Convair 240, which until now has set the pace for this class of airliner.

In single-engine performance—with its important bearing on safety—the Elizabethan will show a substantial advance over any comparable type flying to-day. It sets new one-engine performance standards for a "twin." It will offer for the first time a reasonable rate of climb on one engine with the undercarriage down and, in addition, a performance with wheels retracted significantly better than that of earlier types.

Finally, that fundamental—costs. In spite of the relatively high prime cost of the Elizabethan compared with earlier and less complex aircraft, properly used it gives promise of becoming a far better commercial proposition than any of its forebears. An analysis of the Elizabethan on the London-Paris route, for instance, shows that its specific operating cost for each capacity ton-mile flown is likely to be some 24 per cent less than that of the Viking when each is flown at the same utilization of 1,750 hours per annum. As shown on page 232 the Elizabethan has also a wide spread of sector distances over which its costs are nearly constant. Thus, the best economic stage-length for the Elizabethan is about 550 statute miles, but the specific cost is only some 10 per cent greater per C.T.M. at 1,000 miles or at 350 miles.

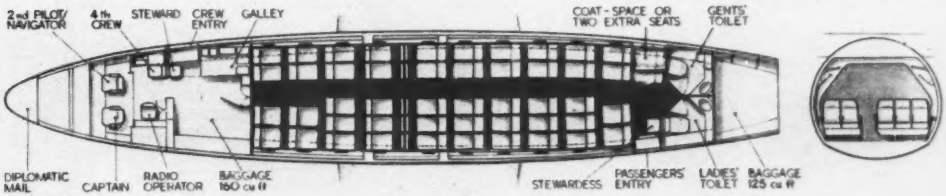
Quantitatively speaking, the operating costs of the Elizabethan over a 550-mile stage, and used at the rate of 2,000 hours per annum—and assuming a network such as that of B.E.A. on the Continent of Europe—are estimated by us to work out approximately as follows, the final figures remaining to be determined in the light of experience:—

	Total Cost	Variable Operating Cost*
Per annum	£221,650	£126,400
Per flying hour	£110.8	£63.2
Per aircraft-mile	11.02 shillings	6.28 shillings
Per capacity ton-mile	27.5 pence	15.7 pence

* Cost directly proportional to number of hours flown and landings made.

These figures are significant, of course, only in terms of the relative value of the £ sterling at the date at which the assessment is made. However, a widely known yardstick can be used

In this 47/49-seater layout for B.E.A. the "fourth-crew" seat is for a check-pilot, trainee or observer.



B.E.A.'s ELIZABETHANS . . .

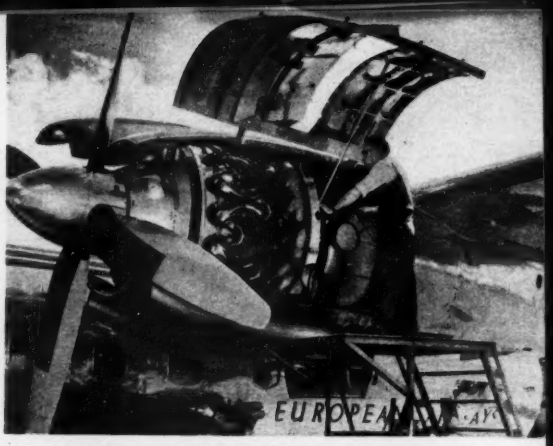
to set the scale when one remarks that, for a similar stage-distance and utilization, and under the same conditions of operation, the cost of the Elizabethan per C.T.M. are some 17 per cent below those of a standard DC-3 operated, like the Elizabethan, with three flying crew but with only one steward compared with the Elizabethan's two.

Incidentally, on this latter point, B.E.A.'s policy is to operate with one steward and one stewardess in each Elizabethan—thereby offering the passenger whichever type of service he or she prefers.

A final point. Some people may have wondered why we in B.E.A. have changed from the manufacturers' name "Ambassador" to the new aircraft class-name "Elizabethan." There are three reasons. First, B.E.A.'s policy is to try to introduce some individuality into its fleet by naming its aircraft after famous persons in British history. Individual names of 20 accredited ministers were, in fact, sought, but the list arrived at did not produce 20 historic names which would be widely recognized. Secondly, there are so many individual features built into B.E.A.'s version of the Ambassador that a separate class-name seemed desirable to distinguish the B.E.A. version from the many others which we may hope will be flying before long with other airlines throughout the world. And, finally, the name "Elizabethan" was an obvious winner from the many submitted in the B.E.A. aircraft-names staff competition.

And so, in the tradition of Imperial Airways' famous old Argosies and Heracles of the 1920s and 1930s, British European Airways looks forward to reintroducing the British "Silver Wing" service with a new aircraft finer than any which has yet flown between London and Paris.

The names of Drake, Raleigh and Hawkins will be seen again over the narrow seas.



An unusually revealing study of an Elizabethan power plant, the heart of which is a Bristol Centaurus 661 eighteen-cylinder sleeve-valve engine.

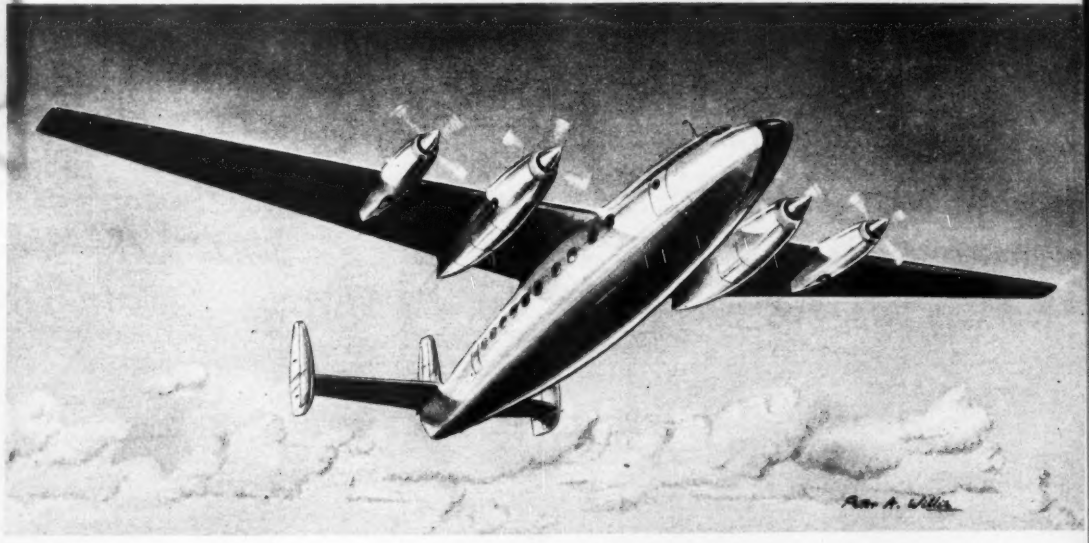
Names of the B.E.A. "ELIZABETHAN" Class

Reg.	Name	Reg.	Name
G-ALZN	Elizabethan	G-ALZY	Sir Philip Sidney
G-AMAD	Sir Francis Drake	G-ALZZ	Edmund Spenser
G-ALZP	Sir Richard Grenville	G-AMAA	Sir Francis Knollys
G-ALZR	Sir Walter Raleigh	G-AMAB	Sir Francis Bacon
G-ALZS	William Shakespeare	G-AMAC	Sir Robert Cecil
G-ALZT	Sir John Hawkins	G-ALZO	Christopher Marlowe
G-ALZU	Lord Burghley	G-AMAE	Earl of Essex
G-ALZV	Earl of Leicester	G-AMAF	Lord Howard of Effingham
G-ALZW	Sir Francis Walsingham	G-AMAG	Sir Thomas Gresham
G-ALZX	Sir John Norris	G-AMAH	Sir Christopher Hatton

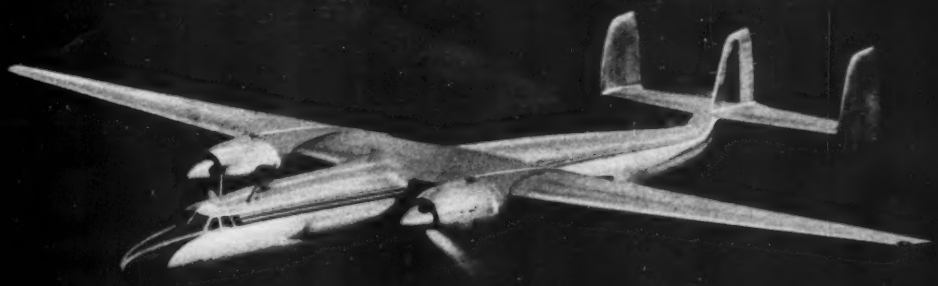
THE DART-AMBASSADOR

IT is clearly evident that the Ambassador is amen able to a great deal of further development or design "stretch", and we now are enabled to publish a preliminary note on a possible version—in which B.E.A. are naturally interested as a future possibility—with four Rolls-Royce Dart R.Da3 turboprops.

Slotted flaps and additional centre-section fuel tanks (already provided for in the design and increasing the total capacity to 1,600 gal) are foreseen, but the present fuselage would, at least in the initial stage of development, be retained. In I.C.A.N. conditions, at its normal all-up weight of 54,500lb, the Dart-Ambassador would reach 50ft in 990yd and at 25,000ft would cruise at 325 m.p.h., the corresponding a.m.p.g. being 1.215. With a payload of 11,645lb the stage distance (with S.B.A.C. fuel allowances for V.F.R.) is estimated to 1,080 miles. The appearance of the Dart-Ambassador is shown, for the first time, in the *Flight* copyright drawing below.



To go into service this year on the routes of British European Airways, the Airspeed Ambassador has the performance expected of a modern airliner with an intrinsic capacity to improve on the high standards of operational economy reached by the previous generations of civil aircraft



AMBASSADOR

BRITISH EUROPEAN AIRWAYS' *Elizabethan* CLASS AIRLINER

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CIVIL AVIATION NEWS

THE BRABAZON REPORT

LORD BRABAZON'S report on an inquiry into the relative responsibilities of captains, operators and airfield authorities in the matter of take-offs and landings in bad weather was published last week in the form of a White Paper.* Undertaken at the request of the Minister of Civil Aviation, the inquiry followed the accident in which a B.E.A. Viking crashed in thick fog at London Airport on October 31st last; 28 of its 30 occupants lost their lives.

Lord Brabazon's principal recommendation was that the responsibility for establishing weather minima should, as at present, remain with the operator. In a subsequent statement to the House of Lords Lord Pakenham said that the Government had accepted the report in principle, including this main recommendation.

Lord Brabazon's report suggested a number of new safety measures, the most important of which was that arrangements should be made for the measurement of "runway visual range" when visibility at airfields fell below one nautical mile. Among the main conclusions reached were the following: (1) In no circumstances should an airfield be closed against emergency landings; where a runway is unserviceable the authorities should inform pilots that the runway is closed; and in cases where notified safety and rescue services are temporarily not available pilots should be informed of the situation and the reasons for it. (2) Runway lighting should be switched on when visibility by day falls below one mile or below a higher figure when requested by a pilot; I.C.A.O. contracting states should also be invited to take parallel action. (3) Existing procedure by which operators of British-registered aircraft are responsible for establishing weather minima should be retained, but State approval should be required for these minima (in the case of foreign operators the minima should be approved by the national authorities concerned and notified to the M.C.A.). (4) When precision or runway approach-aids are used weather minima should be stated in terms of critical height (i.e., the height below which it would be impracticable to carry out an overshoot with adequate terrain clearance); in the case of an approach on which the aircraft desires to circle visually, minima should be stated in terms of ceiling, visibility and runway visual range.

In Lord Brabazon's opinion, the operator should still be held responsible for ensuring that his pilots abide by the minima established. The report also recommended that no change should be made in the existing procedure by which the State can take action against operators who violate these minima.

Although they were outside the terms of reference of the inquiry, Lord Brabazon also appended a number of recommendations which, he thought, would help in furthering air safety. He suggested that Fido equipment should be made available at one airfield in the United Kingdom, which should also be fitted with a comprehensive system of aids to instrument approach. (Manston, the site of the existing Fido installation, is not at present equipped with additional aids.) He also recommended that action to install daylight runway markings should be expedited and that further trials of runway lighting systems should be carried out as quickly as possible.

* *H.M.S.O. Stationery Office, price 9d.*

FOR HELICOPTER PILOTS

FOR some time the application of existing licensing regulations to the piloting of helicopters has been under consideration by the M.C.A. and it has now been decided not to introduce a separate class of licence at the present stage of helicopter development. In future, therefore, the right to pilot helicopters will be conferred by the issue of endorsements on a normal flying licence; the licence itself must, of course, be appropriate to the privileges which the pilot wishes to exercise.

In the case of private pilots, evidence will be required of training under a competent instructor in a helicopter fitted with dual controls; at least five hours' flying as pilot-in-charge is required, not less than three of which must be on cross-country flights. A "reasonable amount of experience" as pilot on the type to which the application relates is another requirement. Technical examinations will be conducted by the A.R.B. on the type in question.

For commercial licences at least 50 hr flying is needed, although this may be reduced to 20 hr in the case of a licence restricted to aerial work. At least 50 hr of cross-country flying on conventional aircraft is required, of which not less than 10 hr must be on helicopters. An alternative to this is a total of 20 hr cross-country on helicopters. Night and instrument ratings are also obtainable, although, for the present, helicopters may be flown in control areas and zones only under V.F.R. conditions.

SOUTH AFRICAN SCENE

RECENT news from South Africa indicates that the Union's air services are in the melting-pot this year, and that some major changes are possible.

At present, protracted negotiations between the Dutch Government and K.L.M. on the one side, and the Union Government and South African Airways on the other, are dragging on week after week over a new agreement concerning the route to Europe. Last year K.L.M. asked Mr. Paul Sauer, the South African Minister of Transport, to consider increasing the present two K.L.M. services from Amsterdam to Johannesburg each week to three during the "season." This led to the present negotiations in Cape Town.

The South African negotiators are understood to have produced figures showing that the traffic between South Africa and Holland justifies, at the most, five services a month. They refuse to entertain any extension and it is thought unlikely that they will even tolerate a continuation of the present twice-weekly frequency. On the South African side, it is believed that 80 per cent of K.L.M.'s traffic is really between South Africa and England. The "end-to-end" principle is being insisted upon, which means that airlines may only book passengers if their real destinations are in the country of which the airline is a national. This principle is a feature of the present agreement between South Africa and Holland.

If South African Airways and their partners, B.O.A.C., get their way, they will, of course, absorb K.L.M.'s traffic, which amounts at present to 88 passengers per week. B.O.A.C. have sufficient Hermes airliners to accommodate the heavy Festival of Britain bookings on extra services even if their regular aircraft are full, and S.A.A. can probably put on a few extra Constellation services if necessary.

The Comet is currently causing some deep thinking among airline officials, for, while it can land at Johannesburg's Palmietfontein Airport (which has a 2,000-yd runway), the fact that the airport altitude is 5,500ft means that it cannot take off with a full payload and enough fuel to reach Nairobi, a distance of 1,815 miles. At a 5,500ft airport the Comet apparently needs something like 2,700 yd for a full-payload take-off with an appreciable amount of fuel.

When Mr. Whitney Straight was in Johannesburg recently he suggested that the Comet should land its passengers at Palmietfontein in the ordinary way, but

SCANDINAVIAN UNITY: A historic moment in Scandinavian aviation was marked on February 8th by the signing of a 25-year pact stipulating full co-operation between A.B.A. (Sweden), D.N.L. (Norway) and D.D.L. (Denmark). Left to right (in front): Mr. Marcus Wallenberg, A.B.A.; Mr. Per M. Hansson, D.N.L., chairman of S.A.S. board; Mr. Per Kampmann, D.D.L. At rear: Mr. Axel Gjores, Mr. E. F. Eckhoff and H.R.H. Prince Axel of Denmark.

CIVIL AVIATION NEWS . . .

that it should take off from the 3,500-yd runway at the new Jan Smuts airport. Passenger-handling facilities will not be finished in time for the Comet, but the runway will, so that passengers could undergo customs, immigration, health and finance formalities at some other centre and then travel in a "bonded coach" to Jan Smuts Airport. The Comet, of course, would fly light between the two airfields.

Meanwhile, it is understood that the Jan Smuts Airport will not be ready before 1954. No temporary buildings are to be erected at the airport; the permanent ones will be installed at the outset. The only buildings at the moment are two engine test-cells put up for the Cyclones used in the Constellations. The S.A.A. workshops at Germiston had no cells big enough for these aircraft and it was decided to build them at Jan Smuts to avoid duplication.

Other South African aviation news includes the fact that S.A.A. are now thinking of selling their remaining four Vikings (B.E.A. recently acquired the first four). Skymasters are now being used between Johannesburg, Port Elizabeth, Cape Town and Bulawayo, and by August it is hoped to have them flying to Durban, where another large airport has been under construction for about five years. Later they will take over the service to Windhoek, in South-west Africa, which is also being provided with a new airport.

Incidentally, one of S.A.A.'s two Doves was sold some time ago and the other is now used mainly for executive work. The company also has five Dakotas—not for sale—and 11 Lodestars, which it is also intended to dispose of; their fleet would then consist of Constellations, Skymasters and Dakotas.

Financially, this streamlining would obviously help the airline. Where, previously, the company's small overall profit had always been due to the large surplus obtained on the London services, recently acquired Skymaster and Dakota replacements have enabled S.A.A. to make a profit on internal routes for the first time. If South Africa's intention to reduce K.L.M.'s services succeeds, the profits will certainly grow to a really substantial figure.

BREVITIES

THE Office of the Attorney General has announced that Sir Hartley Shawcross is to appear for the Crown and will represent public interest at the inquiry into the accident to B.E.A.'s *Viking* G-AHPN which crashed in fog with a loss of 28 lives at London Airport on October 31st. The inquiry opened in London on February 19th. It is being held under the chairmanship of Sir Walter Monckton, K.C., M.P.

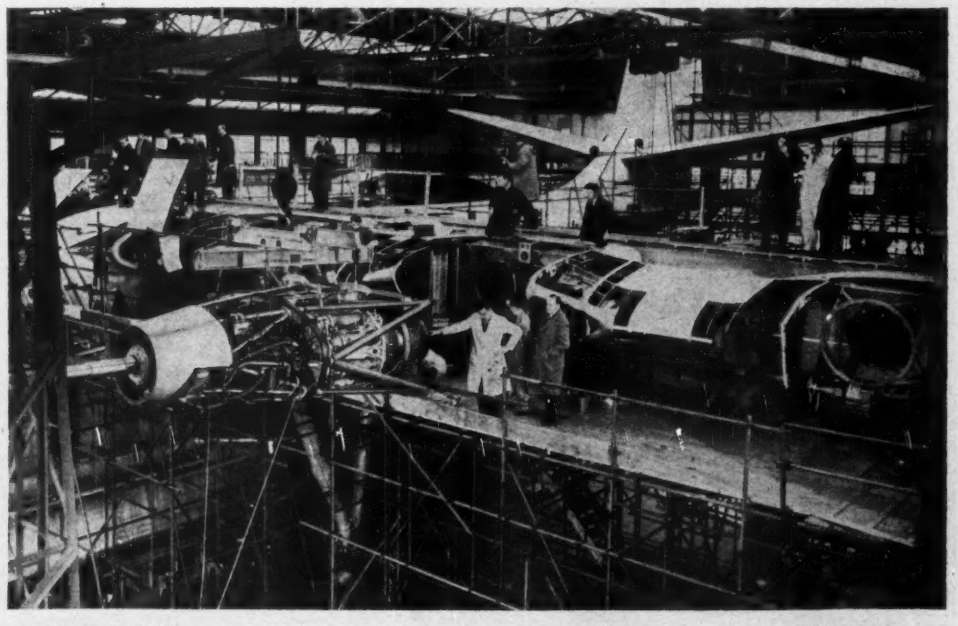
* * *

Following a route trial on February 13th, S.A.S. will inaugurate a new bi-weekly between Scandinavia and Chile. The route, which is the longest in the S.A.S. network, will then provide the speediest link between Europe and Chile. Elapsed time for the 8,900 miles from Stockholm to Santiago is about 46 hours. S.A.S. route-network now totals 46,000 miles.

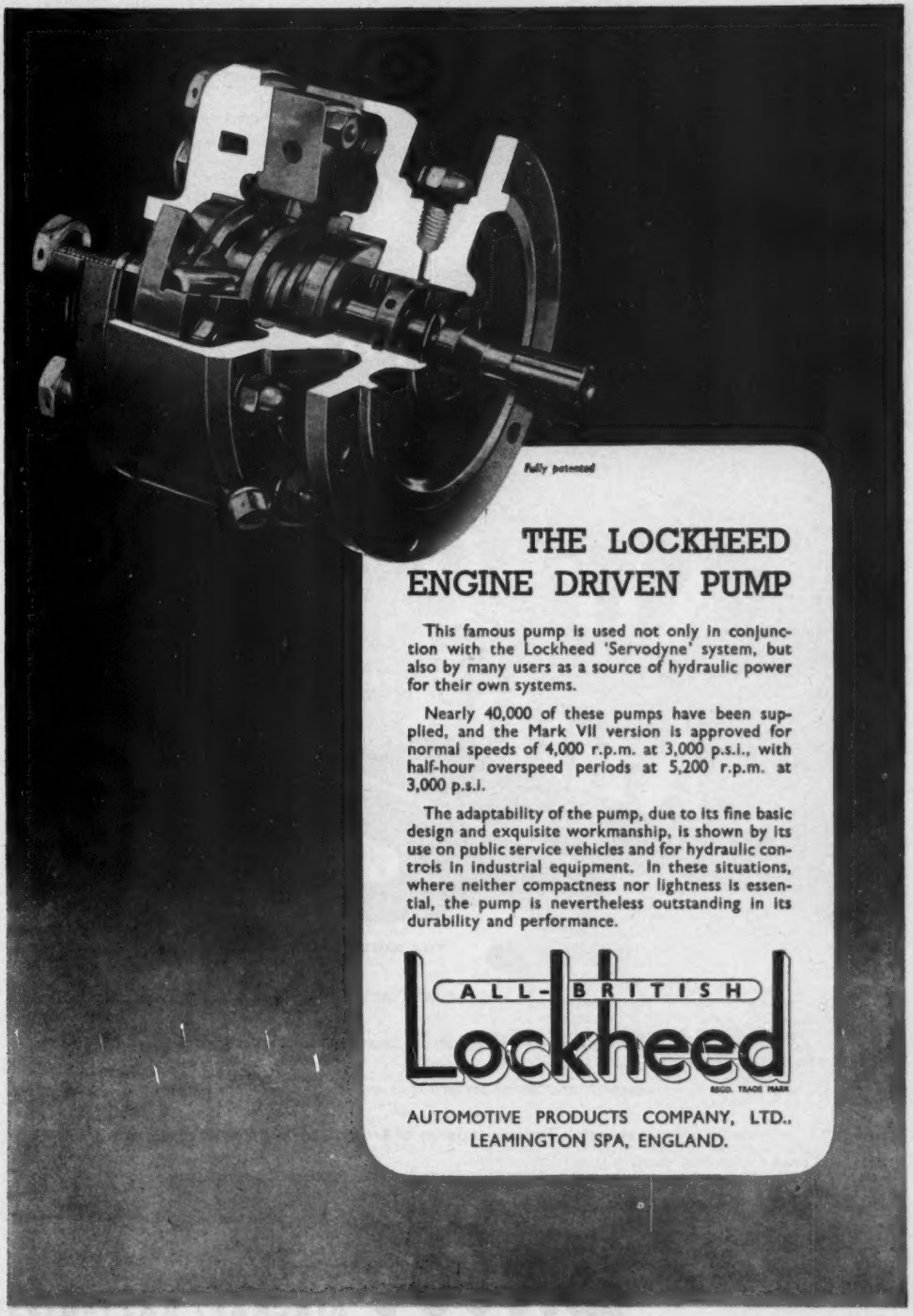
For the second consecutive year United Air Lines have been presented with the "Fashion Academy Gold Medal Award" for operating the "best-dressed" aircraft in America. Last year was the first occasion on which the award had been made to an airline.

* * *

Replying to a question in the House of Commons last week as to whether he was aware of the fact that large cosmic-research balloons flying over London were causing concern to pilots, Mr. Frank Beswick, Parliamentary Secretary to the M.C.A., said that while these balloons were subject to the Rules of the Air, as contained in the Air Navigation Order, 1949, as an added safeguard an order was being prepared requiring the prior permission of the Minister before a balloon is released. Presumably the order will exclude the ordinary small radio-sonde.



PRINCESS PROGRESS: The eagerly awaited first flight of the 140-ton Saunders-Roe Princess flying-boat draws nearer as the first pair of coupled Proteus power units is installed. Each combined unit weighs about five tons, the aggregate output being in the region of 7,000 e.h.p. The ten Proteus turboprops (four coupled and two single units) will give the Princess a cruising speed of 380 m.p.h. and a still-air range of 5,500 miles. Span is 219ft 6in, (with floats retracted to form the wing-tips), length 148ft, and height 55ft 9in.



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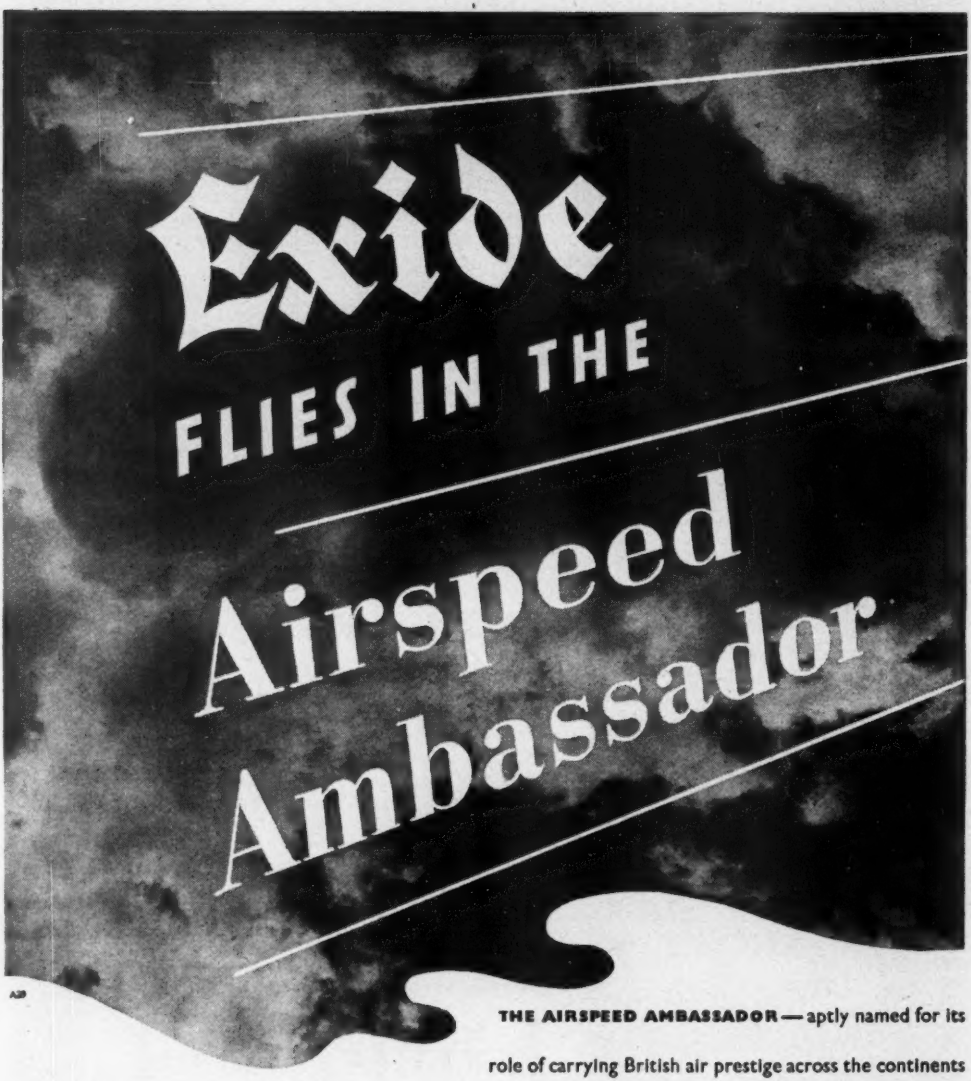

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CIVIL AVIATION NEWS . . .

For the year ended December 31st, 1950, the Kingsford-Smith Airport at Mascot recorded a total of 792,956 passengers, including 42,200 from overseas flights. Comparative figures for London and Northolt airports for last year are approximately 500,000 and 750,000 respectively, so that Mascot airport has thus become one of the busiest in the world. An interesting sidelight on the volume of traffic is that aircraft using Mascot consume a total of 21,500 gallons of fuel per day.

* * *

A new and highly acceptable publication by International Aeradio, Ltd., is the *Air Mileage Handbook*, containing over 5,000 Great Circle and Rhumb-line distances between several hundreds of the world's airfields. It is designed to provide an accurate and easily accessible reference for all concerned with charter costing or flight planning. All distances have been computed to formulæ accepted by I.A.T.A. The cost is £2 2s, and I.A.L. will supply to subscribers, free of charge, any track or distance not already incorporated in the handbook.

* * *

In the last quarter of 1950, P.A.W.A. flew a total of 331,652,000 passenger-miles and 14,483,617 aircraft-miles, as compared with 272,414,000 passenger-miles and 15,662,250 aircraft-miles during the corresponding period of the previous year. The company, incidentally, has recently applied to the C.A.B. for permission to serve the Society Islands (Tahiti) which is to be a stop between Canton Island and Fiji on the route from San Francisco to Australia. Although unsatisfactory transport facilities have in recent years been responsible for a decline in its popularity, before the war the French colony of Tahiti was a favourite stopping-point for tourists on South Sea cruises.

Overseas buyers visiting the 1951 British Industries Fair, which is being held in London and Birmingham from April 30th to May 11th, will be able to take advantage of transatlantic off-season rates offered by B.O.A.C.; passengers travelling within the prescribed off-peak periods will enjoy a ten per cent rebate on the normal fare. In addition, Air Enterprises, Ltd., of Croydon, are operating a daily service between Croydon, Hendon and Castle Bromwich throughout the period of the Fair; a return ticket is £4 18s.

* * *

The Miles Mercury M.28 which was recently flown to Australia by two sheep-station owners, Mr. F. S. Burt and Mr. L. McTaggart (a photograph appeared in *Flight* of February 8th) was the first aircraft of its kind to enter that country. The London agents who supplied it, W. S. Shackleton, Ltd., had also supplied the first Messenger to reach Australia and the first three Messengers to enter New Zealand; they recently made a shipment, too, of the first Auster Vs—powered by 130 h.p. Lycoming flat fours—to these two countries.

* * *

In reminding aircraft captains who fly under Airways Control in the United Kingdom that it is their responsibility to remain within the lateral limits of the airways, *M.C.A. Information Circular* No. 23/1951 draws attention to the fact that in the airways between 3,000 and 5,000ft military aircraft are not obliged to comply with airways procedures. Although Service machines are normally subject to quadrantal height separation rules under I.F.R., it is not possible to ensure that safe separation standards are being maintained at all times between military and civil aircraft at altitudes below 5,000ft. In other words, should an airline pilot, pressing homewards through the murk, find himself confronted with a Meteor closing at alarming speed, he should not be unduly surprised; at least the incident has an explanation.

CLUB AND GLIDING NEWS

FOLLOWING the departure of G/C. E. L. Mole to an appointment as Director of Civil Aviation in the Bahamas, Mr. Maurice Imray has been provisionally elected acting chairman of the Ultra-Light Aircraft Association. At the annual general meeting, which is to be held on March 31st, members of the executive committee will be re-elected.

Capt. E. S. Davis (chairman of the operations sub-committee) has been provisionally elected vice-chairman of the Association in place of Mr. Imray. The U.L.A.A. has also lost two more founder members in the persons of Mr. Ronald Clegg (first chairman of the executive committee) and F/O. Ian Imray; these members have taken up appointments in Hong Kong and Central Africa respectively, and the Association is hoping that at least three new overseas groups should, therefore, appear within the next few months.

There are now 11 projects in the ultra-light category which are either already flying or in course of construction. They include the familiar Slingsby Motor Tutor, the Dart Kitten, the Chilton and the Britten-Norman B.N. 1.F. parasol-wing single-seater. Work has also gone ahead with development of the Fairey Junior, although the manufacturers have not yet released this design for home construction by amateurs. Other types under development are the Sheiaa and Ilgen two-seat trainers; the U.L.A.P. primary trainer (powered by a 26 h.p. Aeronca-J.A.P. engine), now awaiting C. of A.; and the Hoppicopter, a simple single-seat helicopter of American design with twin rotors powered by a modified 50 h.p. Triumph Thunderbird motor-cycle engine. The U.L.A.A. has also published a specification for a two-seat trainer of conventional, low-wing, fixed-undercarriage configuration. Several U.L.A.A. members are also concerned in the construction of Lord Ventry's interesting "ultra-light" airship, whose envelope is to be of 45,000 cu ft capacity and 108ft in length. When completed the airship—which was described in *Flight* of November 16th, 1950—will be capable of carrying from five to six persons on short flights and have a maximum endurance of eight hours.

So far as engines are concerned, the Association has been able to purchase, with the assistance of the Kemsley Flying Trust, a number of unused 36 h.p. Aeronca-J.A.P.s, together with a large quantity of spares. These units are now being made available for sale to members at £60 each.

Despite intensive efforts by the Association, engine manufacturers in general are said to have been reluctant to risk their capital on development of a purely ultra-light power unit until an assured market was available. The one exception is, apparently, the Coventry Victor Motor Co., who are now converting the Neptune engine for use in ultra-light machines; this unit has the advantage of being already in quantity production and having been well proved in various industrial applications. The first experimental conversion is now giving 40 h.p. at 3,000 r.p.m. for a weight of 290 lb; it is to be installed in a Dart Kitten for flight tests. Subsequent units are expected to develop 150 h.p. and to weigh only 140 lb.

Unfortunately, little progress has been made by the U.L.A.A. in the difficult task of persuading British manufacturers to undertake production of the successful German Zündapp 52 h.p. inverted four-cylinder "in-line" of 1939 vintage.

THE Council of the British Gliding Association has endorsed the following annual awards which were recommended by the Flying Committee: the *de Havilland Trophy*, awarded to F/L. A. W. Bedford, A.F.C., for an absolute height of 21,345ft and gain of 19,120ft during his flight from Odiham in an Olympia on August 24th, 1950; the *Manio Cup* to P. A. Wills, C.B.E., for a goal flight of 134 miles in a Weihe from Camphill to Cottishall at the National Contests on July 27th, 1950; the *Wakefield Trophy* to Lorne Welch for a distance flight of 203 miles in a Weihe from Redhill to Melsbroek (Brussels) on April 12th, 1950; the *Volk Cup* to J.A.C. Karran and W. Kahn for their out-and-return flights of 141 miles in Olympias from Redhill to Netheravon on July 2nd; and the *Seager Cup* to J. Grantham and A. R. I. Austin in a Kranich for a goal flight of 85 miles from Camphill to Ingoldmells, Lincs, at the National Contest on July 24th.

The awards will be presented after the annual general meeting, which is being held at 2.30 p.m. on Saturday, March 17th, at Londonderry House.

The B.G.A. has also confirmed the dates for the National Championships; they will be held from July 22nd to 29th inclusive, with the 21st as a practice day. Qualifications for pilots wishing to enter are: possession of a "C" gliding certificate; at least 20 hours' solo flying, of which five must have been devoted to hill soaring and must include a 50 km cross-country on aircraft of up to 1,250 lb a.u.w.; at least ten winch launches; and possession of a valid F.A.I. competitor's licence. The organizers may also require evidence of the fact that pilots are in current flying practice.

The Royal Aero Club has asked the council of the B.G.A. for suggestions for a display of gliding aerobatics which are to take place at the Festival of Britain National Air Races on June 23rd at Hatfield. Clubs who desire to provide this display should send details to the secretary of the B.G.A. by March 20th. At least two gliders would be required and approximately £50 will be made available to cover expenses.

The B.G.A. is to hold its instructors' conference at the London Gliding Club at Dunstable on March 18th, and clubs throughout the country are requested to advise the secretary of the B.G.A. by March 1st of their intention to be represented.

MAKING AIR TRANSPORT PAY

Mr. Masefield's Brancker Memorial Lecture. Part II: The Historical Background Continued: Operating Costs Then and Now

LAST week we gave abstracts from the first part of the Ninth Brancker Memorial Lecture. The paper was read before the Institute of Transport on February 12th by Mr. Peter Masefield, M.A., F.R.Ae.S., M.Inst.T., chief executive of British European Airways, and in it he recalled the historical background of British air transport. His review continued—as will be seen from the abstracts which, in the following pages, form this second instalment—to the time of the formation of B.O.A.C. and B.E.A. He then went on, as will also be shown, to make some revealing comparisons of airline operating costs as between the old and the new régimes. From that he passed to a discussion of the old and new airliner types in their relation to particular requirements. The final section of his paper, an economic analysis, we shall deal with subsequently.

The lecturer said that in its 16 years of existence, up to April 1st, 1940, Imperial Airways carried, in all, some 575,900 passengers, operated a total of 89,446,500 capacity ton-miles in 512,000 flying hours at a load-factor of 67.7 per cent, and achieved 60,621,000 revenue load ton-miles. A commentary on the advance in air transport in the public service was that in the first six months of the year 1950-51 British European Airways carried more passengers than did Imperial Airways in all its 16 years of pioneering existence.

Imperial Airways did more than lay the foundations on which subsequent operations have been built throughout the world; it engendered an immense pride on the part of its staff in its achievements—a pride which existed even to this day.

During those 16 years—starting with such aircraft as the eight-passenger single-engined D.H.34s and ending with the historic 24-passenger four-engined Short Empire flying-boats—the company incurred a gross loss of £5,770,000. Relative money values for this period (1924-39), however, meant that the pound sterling of that time was worth £2.8 at today's rate.

Imperial Airways' costs and losses must also be judged in the light of the pioneering work that the company was doing—including the provision of airway facilities along new Empire trails and the development costs of opening up new routes. Their policy of economy combined with Government lethargy did, however, lead to a falling short in technical progress in competition with foreign rivals, and caused a lag which was only partially recovered by the introduction of the Short Empire boats in 1936.

For a time Imperial Airways had the field almost to themselves. Not until the 1930s did air transport appear sufficiently attractive for private companies to re-enter the field on any large scale. During the latter inter-war years, a large number of other British scheduled airline operators appeared, and although their existence was in many cases brief, a number made lasting contributions to air transport.

Road, Rail and Air

Both road transport and railway interests played a substantial part in the development of internal air routes—and lost a good deal of money in the process. Prominent among the independent companies was Hillman Airways, Ltd., founded in November, 1931, by Mr. Edward Hillman, who brought road transport's "down to earth" methods and competitive initiative into aviation. After his death the company was amalgamated, on October 1st, 1935, with United Airways and Spartan Air Lines, and shortly afterwards, with British Continental Airways, was absorbed into British Airways, Ltd., under the aegis of the Whitehall Securities Corporation. This combination showed up the technical obsolescence of Imperial Airways' equipment on short-haul routes by introducing fast American-built aircraft alongside them and capturing much business.

This combine was itself amalgamated with Imperial Airways to form the British Overseas Airways Corporation on April 1st, 1940—a single "chosen instrument" which (as might be recalled in these days of State monopolies) was the product of a Conservative Government. For that reason it was to be hoped that air transport might now be lifted out of the arena of political party controversy, into which it had never happily fitted.

Mr. Masefield then listed in some detail the formation of various companies in Scotland and the North. In June, 1935, Whitehall Securities acquired control of three of these concerns, and made them responsible for all the internal routes of British Airways, Ltd. A further amalgamation in 1937 resulted in the formation of Scottish Airways, Ltd., with railway interests participating alongside Whitehall Securities. Incidentally, as early as May, 1934, Highland Airways had begun to carry all first-class mails between the mainland of Scotland and the Orkneys on an all-up basis. That was the first application of this principle apart from Sweden's adoption of all-up air mails in 1928.

The operations of Mr. E. L. Gandar Dower, Jersey Airways and Guernsey Airways, were also briefly reviewed by the lecturer.

After a few trial services operated by Imperial Airways for the G.W.R., the railways decided, in 1934, that the time had come to enter the coming competitive industry—air transport; they therefore took up powers granted to them by Parliament in 1929. Their efforts, although widespread, were on the whole half-hearted, competition with railway main-line services being carefully avoided. The services were at first operated on their behalf by Imperial Airways. Eventually the Railway Group spread to include Scottish Airways, Olley Air Service, Isle of Man Air Services, Great Western and Southern Air Lines (to the Scilly Isles), West Coast Air Services to Dublin and extended to Channel Islands Airways, with Jersey and Guernsey Airways.

On the statistical side, the private companies (other than Imperial Airways) which operated between 1924 and 1939 flew some 24,600,000 capacity ton-miles and achieved about 8,540,000 revenue-load ton-miles in approximately 265,000 flying hours. They earned a revenue of some £1,722,000 and incurred an expenditure estimated at £3,231,000. Thus their operating costs worked out at some 31.5d. per c.t.m. and their loss at £1,509,000.

Among those who were prominent at the end of this period in 1939, and who remained in the centre of air transport affairs today, were Maj. Ronald McCrindle, managing director of British Airways (now with B.O.A.C.); Lord Amherst, general manager of Great Western and Southern Air Lines (now with B.E.A.); Alan Campbell-Orde, operating manager of Imperial Airways (now with B.O.A.C.); R. L. Carter, manager of Isle of Man Air Services (now with B.E.A.); G. O. Waters, general manager of Jersey Airways (now with B.E.A.); Gordon P. Olley, managing director of Olley Air Service, Ltd. (still Olley); W/C. A. H. Measures, superintendent of Railway Air Services (now with B.E.A.); and Whitney Straight, chairman of the Straight Corporation and of Western Airways (now with B.O.A.C.).

The Interruption

When war broke out in 1939, "National Air Communications"—an ill-conceived affair—was set up to operate an air-transport pool in the British Isles and to the Continent. In May, 1940, N.A.C. activities were absorbed by the R.A.F., while the railway-sponsored companies continued to operate skeleton services through the Associated Airways Joint Committee. In addition Allied Airways (Gandar Dower), Ltd., continued throughout the war.

Meanwhile—an epic story that has been told elsewhere—B.O.A.C. was formed in the midst of war and continued essential services throughout the six years of strife.

On August 1st, 1946, the British European Airways Corporation was split off from B.O.A.C. for the operation of internal and European services. B.E.A. took over the European services of 110 Wing, 46 Group, R.A.F., which had operated for a short time under the aegis of B.O.A.C., and, on February 1st, 1947, combined with them the services of the Associated Airways Joint Committee which controlled the remnants of the railway-sea group of companies.

In the past two years the two corporations had settled down to commercial endeavours under Lord Douglas, chairman of B.E.A., and Sir Miles Thomas, chairman of B.O.A.C.

Such, in the broadest outline, was the record of the many chops and changes which had beset the path of British air transport during its first 32 years. We may hope [continued Mr. Masefield] that a certain stability has now been reached and that control by conflicting interests has been eliminated. Equally, I trust that air transport will never be put under the responsibilities of a Transport Ministry primarily concerned with the older forms of transport with all their vested interests. Under a Ministry of its own, British air transport now flies on its own wings: they are developing steadily.

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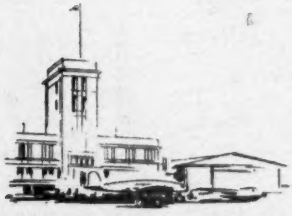

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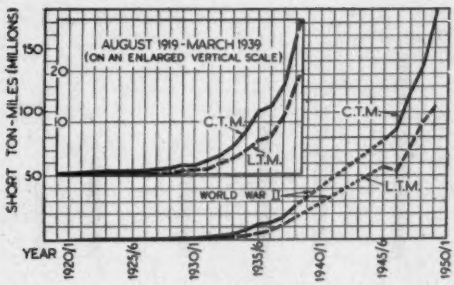

Fig. 1.—Capacity and load ton-miles flown by British air transport from August, 1919, to March, 1950.

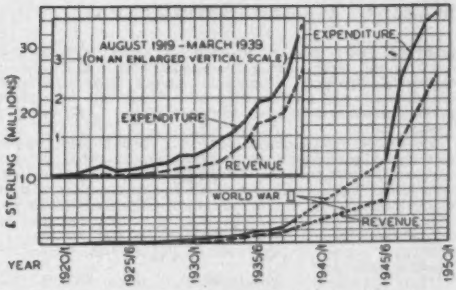

Fig. 2.—Revenue and expenditure—the financial picture for the years from August, 1919, to March, 1950.

MAKING AIR TRANSPORT PAY . . .

records, in the 32 years from August, 1919, until August, 1950—setting aside the six years of war—British commercial air transport has flown some 300,000,000 aircraft-miles, has carried some 5,100,000 passengers, and has operated some 801,000,000 capacity ton-miles.

A compilation of the traffic figures achieved during this period is set out graphically in Fig. 1. An interesting point is that in the five post-war years British air transport has carried two and a half times as many passengers for eight times as many passenger-miles as were flown in the 20 inter-war years from 1919. The post-war intensity of operation is thus 30 times as great.

British operators have earned in revenue some £114,000,000 sterling, 89.8 per cent of it since the war—a figure which does not reflect the difference in currency values. On the debit side, the operating expenditure in the 32 years has amounted to something like £174,500,000. That means an operating loss of approximately £60,500,000 on the deal—a deficit which works out at a loss of about 4s for each aircraft-mile flown, or 18d loss per capacity ton-mile. The financial picture over the years 1919-50 was shown in the table published last week and is illustrated graphically in Fig. 2 above.

Yet, in this generation of operations, the annual turnover has been built up from the £27,000 revenue for the year 1919-20 to the combined revenue of £26,416,000 achieved by B.O.A.C. and B.E.A. in 1949-50. The all-in operating cost has come down from the 69.2d per capacity ton-mile of 1924 (at the higher value of money) to the 43.9d per capacity ton-mile of 1950. Most significantly, the fares have been reduced—in an era of rising prices—from an average of 7.12d per passenger-mile in 1922 to an average of 5.68d today.

All these comparative figures must be judged in relation to the fluctuation in the value of money since 1919. Fig. 3 shows the equivalent annual value of the pound sterling based on the average rate for 1950, while Figs. 4 and 5 set out in graphical form a comparison of operating results converted into similar money values at today's rate.

Whereas some of the pre-war specific operating costs per capacity ton-mile appear low in terms of actual money paid, when they are compared in equivalent 1950 money values a more accurate picture is brought out. They are seen to be relatively much higher. Thus, Imperial Airways, during their 16 pioneering years of operation, reduced the mean specific cost to some 12 per cent below the costs of the first four years. The private operators—with much less development expenditure and more modest standards—achieved a mean reduction of some 30 per cent. Since the war the two British Airways Corporations—in spite of inflated costs immediately following the war years—have achieved a mean specific cost which is 44 per cent below the original level and 37 per cent below the costs per capacity ton-mile of Imperial Airways. They can do better yet.

Compared with the mean specific operating cost of 68d per c.t.m. achieved by the British Airways Corporations during the period 1945-50, B.E.A.'s specific operating cost today stands at 44d per c.t.m.—about one-third of Imperial Airways' costs—whereas the loss is down to 5.5d per c.t.m.—one-eighth of the inter-war rate.

All these figures show that, converted into equivalent money values of 1950, and in spite of an actual money loss of £60,500,000 in 32 years, British air transport has been making steady progress towards an eventually profitable state, reducing its costs while keeping its fares approximately constant. The margin between

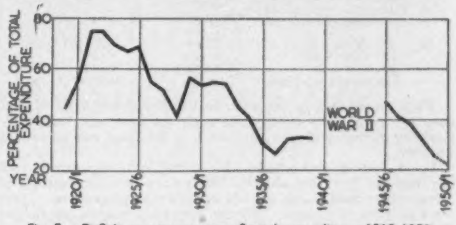

Fig. 5.—Deficit as a percentage of total expenditure, 1919-1950.

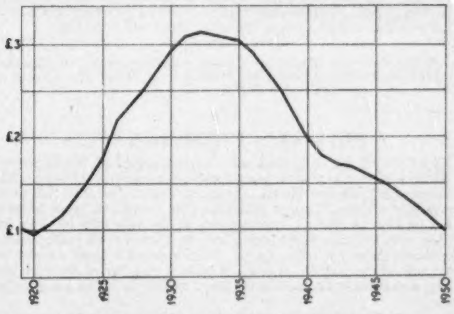

Fig. 3.—Equivalent value of the pound sterling based on its average rate in 1950 (from smoothed curve of wholesale prices index).

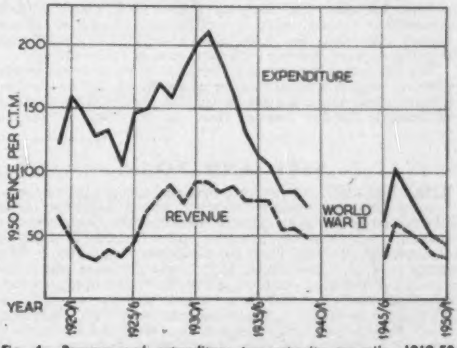

Fig. 4.—Revenue and expenditure per capacity ton-mile, 1919-50, expressed in 1950 currency equivalents.

MAKING AIR TRANSPORT PAY...

profit and loss is now narrow—although a drop in travel as a result of still more acute international tension could widen it catastrophically again. Improved aircraft and streamlined organizations can convert substantial losses into substantial profits—provided there is no further rapid fall in the value of money.

My belief is that, during the course of the next generation of air transport, the losses of £60,500,000 incurred between 1919 and 1950 can be made good out of future profits. That is if, indeed, large profits should be the aim, which I suggest is not a primary requirement. Rather, as costs continue to come down so that the "break-even" point is reached at existing fares, I shall hope to see the fares brought down in sympathy, so that air transport becomes a means of large-scale public transport within the financial reach of all.

There is a school of thought, however, which takes the view that, in the cause of national prestige and of world trade, first-class air services should be expanded and pressed forward, whatever the cost. I do not take so pessimistic a view of the prospects. In spite of heavy losses in the past, the history of the business clearly shows a steady trend towards a profitable state.

Turning now to the question of operational progress, and taking the London-Paris route as an example, it is interesting to compare the advance in performance made in 30 years—the contrast between the Handley Page 0/10s of 1921 and the Airspeed Elizabethans of B.E.A. The comparative characteristics of the two machines are :—

	1921 H.P. 0/10	1951 Elizabethan
Passenger seats ...	10	47
Wing span	100ft	115ft
Wing area	1,642 sq ft	1,200 sq ft
Gross weight	14,000 lb	52,000 lb
Take-off power ...	2 x 355 b.h.p.	2 x 2,700 b.h.p.
Normal cruising speed	80 m.p.h.	260 m.p.h.
Variable operating costs (in 1951 units):—		
per flying hour ...	£20.5	£88.3
per aircraft mile ...	6.34s	9.61s
per seat-mile ...	7.61d	2.45d
per capacity ton-mile	60.85d	22.50d

Thus we see that in 30 years, on the Paris route, speeds have gone up by 225 per cent, while costs per seat-mile have come down by 68 per cent. No other form of transport can boast such progress.

But in spite of this advance, the saving in journey time which the operator has been able to offer to the travelling public on certain short-haul routes has not improved in proportion. There are a number of reasons. Airports have been pushed out farther from city centres, formalities for passengers have been increased and there is more traffic congestion on the roads and in the traffic buildings. Just as significant are the effects of increased taxying time to the ends of runways, the more spread-out circuit and approach patterns necessary with modern aircraft and the longer routeing caused by the requirements of Air Traffic Control.

While cruising speeds were increasing by 225 per cent between 1921 and 1951, journey speeds (from the centre of London to the centre of Paris) have risen only from 53 m.p.h. in 1921 to 71 m.p.h. in 1951—a modest increase of 35 per cent. The journey time by the Vickers Viking today saves only 12 minutes between city centres compared with that of the H.P.45 Heracles of 20 years ago. Introduction of the Airspeed Elizabethan will improve this somewhat. Even so, the time saved cannot amount to more than about 20 minutes—still giving a substantially longer journey time than the A.W. Ensign and D.H. Albatross of Imperial Airways achieved for a short time in 1938 and 1939.

The fact is that the orthodox aircraft as a vehicle is not ideally suited to stage-lengths so short as 200 miles. It can earn profits if high-density traffic is available on such a stage and can offer a substantially quicker journey than can any form of surface transport when sea crossings are involved. But in the past 20 years it has not been able to speed up short inter-city journeys by many minutes. The impending increase of cruising speeds to 500 m.p.h. will not, on such short stages, save more than a few additional minutes. The solution for short distances will undoubtedly be provided by the large helicopter operating directly from city centre to city centre. Twenty years hence, the journey time from the centre of London to the centre of Paris may, I hope, be reduced from 3½ hours to not much more than 1½ hours—by helicopter. Moreover, in the long term, many short-haul routes (particularly internally) which can never do other than lose money with fixed-wing types may be converted to profitable ventures by helicopters designed for the job.

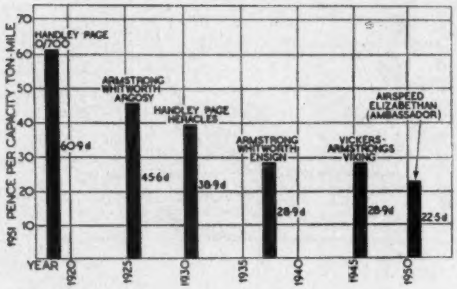

Fig. 6.—Variable costs per capacity ton-mile for aircraft used on the London-Paris route from 1919 to 1951.

Although time saved to the traveller on short stages has made little progress, the standard of service has improved in other respects. Thus, while the higher cruising speeds have done surprisingly little to speed up the average journey, they have had a striking effect on regularity and punctuality. Thirty years ago the effect of different winds sometimes varied the London-Paris time of a Handley Page 0/10 by as much as two hours. The corresponding effect of the same wind variation on the Elizabethan is about 10 minutes. Standards of accommodation have improved substantially, even compared with the Heracles, while the contrast between the smooth passage of a modern pressurized aircraft above the worst of the weather and the painful wallowing of the old lightly loaded biplanes, largely flying "contact" below the clouds, requires no emphasis. Thus in its widest sense the operational progress, offering increased punctuality, reliability and comfort, has been as marked as has the progress in the economic field.

This economic progress can be appreciated more readily by contrasting the operating costs of successive types of aircraft on the London-Paris route. The variable operating costs for leading types of transport aircraft used between London and Paris from 1921 to 1951 are set out in Fig. 6.

A point worth remarking is that the variable operating cost of the Viking today is even further below that of the famous old H.P.45* Heracles than the Heracles was below that of the Argosy. On the other hand, were the Ensign available today—particularly in the form in which it might have developed but for the war—it would be a most economic type for London-Paris services.

An encouraging feature of the assessment is that the rate of reduction in variable operating cost is almost as steep today as it has ever been. With the turbine era ahead of us we can hope that the progress towards lower operating costs will continue.

(to be continued)

* *The Western (or European) Heracles version of the H.P.42 Hannibal was usually, and inaccurately, also referred to as an H.P.42. Aircraft of the Heracles class were in fact H.P.45s.*

FIRE AND FOAM

FIRE-PREVENTION officers, designers of fire-fighting equipment and others similarly interested should find some useful information in a report recently issued by the Department of Scientific and Industrial Research under the title *A Study of Mechanically Produced Foam for Combating Petrol Fires.** The author is N. O. Clark, Ph.D., D.I.C., and the major part of his work is a record of an extensive and detailed series of experiments with foam, both in the laboratory and on test-fires out-of-doors.

Though now issued as a new publication by H.M. Stationery Office, the report actually emerged from the D.S.I.R. Chemical Research Laboratory in 1947 : nevertheless, since most of the information it contains is fundamental, it remains of value.

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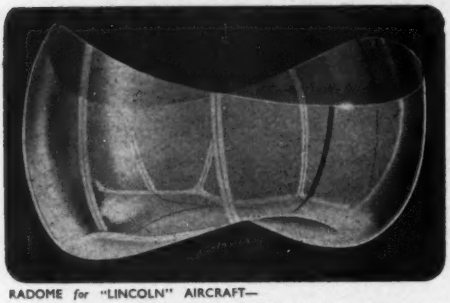

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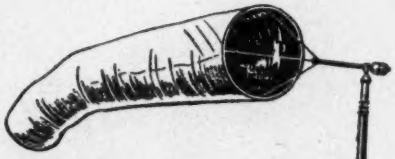

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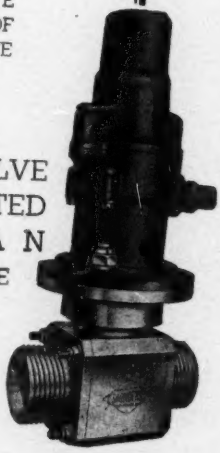

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"B.E.A."—A Prior Claim

ONE cannot help regarding it as most unfortunate that two important British nationalized organizations should each have the initial letters "B.E.A." But whereas British European Airways have over a period used and publicized the three initials and incorporated them in their insignia, the British Electricity Authority has only recently come into the picture. I suspect that the daily newspapers are as much to blame as anyone for the confusion which now arises, streamlining screamlines and subheadings into their narrow columns as they do.

What, for instance, is one to understand by "B.E.A. shows profit for first time," or "Strike of B.E.A. electricians," or again, "B.E.A. installs new lighting system"? And what of the timid airline passenger who has enough aeronautical knowledge to place an unfortunate interpretation upon "B.E.A. power cuts—chairman's statement"?

I suggest that a plea be addressed "to all whom it may concern" for immediate agreement to standardize upon "British Electricity" and "B.E.A.," thereby preventing confusion from multiplying.

London, E.C.3. A. JENKINS.

[We entirely agree. It can be only a matter of time before something serious occurs as a result of this confusion.—ED.]

Fighter Armament

THE arguments of W/C. Colin Gray (*Flight*, February 15th) against my analysis of air-combat statistics deserve closer consideration.

Surely, the Battle of Britain was not a straight fighter *versus* bomber conflict? Most of the Allied losses were inflicted by Luftwaffe fighters, but the German bombers had no effective armament and became, if caught at close range, helpless victims of the defending fighters (the number of our victories would have been far higher had British fighters carried shell-guns). The deficient bomber armament largely made up for the fighter protection.

The Allied bomber of 1944-45 not only enjoyed a powerful and most effective defensive armament, but also flew, at least in daytime, in close box formation. This rendered fighter attacks rather hazardous.

Hence it should not be misleading to compare these combat statistics. Nor is it a sweeping conjecture to say that the probability of "downing" an enemy bomber, with a chance of survival, was higher in 1946 than during 1944-45. Consequently, my assessment of the technical progress in armament attained in Germany by the end of the war does not err.

As to comparing air-combat results between the Fw 190 and Me 262, reliable information (on both sides) agrees that the former was eminently practical and, in particular, very manœuvrable. The Me 262—originally conceived as a fighter but developed as a day bomber and experimentally re-converted as a fighter—was much less manœuvrable, required more maintenance, was less liked by pilots, but was appreciably faster. As was done by Luftwaffe experts, my evaluation presumed as equal overall tactical value of both aircraft *as weapon carriers*. Contrary to W/C. Gray's contention, this might even err in disfavour of the Fw 190. A former Luftwaffe air-combat expert (Col. Gordon M. Gollob), the very same specialist who had been responsible for the progressive rocket-missile armament of Me 262, quite recently argued that *airscrew-driven* fighters still possessed so many advantages over jet fighters that they should in no circumstances be discarded. Col. Gollob's operational experience is, of course, restricted to the Me 262. The inference is obvious.

W/C. Gray says that the Me 262, because of higher speed, was less vulnerable to return-fire. Its diminished manœuvrability must largely have made up for such protection (besides granting less opportunity for attack and reduced probability of producing hits upon the bomber).

Although none of the arguments brought forward would affect the conclusions reached in my articles, a final observation seems indicated to avoid misinterpretation. It is easy to sympathize with the outlook of a fighter pilot who enjoys nothing more than a scrap with opposing fighters. But that is of no use for air defence. It is the shot-down bomber which counts and the bomber whose mission has been frustrated (the bomber downed after having dropped its load is of minor value, too). German air-combat statistics referred to the number of destroyed bombers, and in future it would be wise to rate victories over enemy fighters lower than those over bombers, reconnaissance and/or ground attack aircraft.

Dunstable. A. R. WEYL.

Curious Security

DURING recent months on several occasions, I have noticed, with some concern, that British aeronautical magazines have been forced to wait until the usual "foreign sources" give news of new aircraft and engine developments being made in this country before they themselves are enabled to mention such things. Here are three examples from your excellent publication alone :—

(1) December 21st : ". . . the October 9th issue of our American contemporary *Aviation Week* included an article on the Beta rocket motor . . . and gave data on the unit which English journals were not permitted to publish."

(2) December 21st : "American sources have announced a third British delta, constructed by the Fairey Company. . . ."

(3) February 8th : "No information may be published concerning any British jet bomber other than the Canberra, but foreign reports have mentioned jet-bomber projects by four companies responsible for bombers during the last war Vickers, Handley-Page, Short and Avro."

Why is it that this ludicrous state of affairs is allowed to exist? Surely, if our allies can collect such information, *and* publish it when it is of no particular importance to their ordinary public, then, using all available means, the agents of a potential aggressor would conceivably be able to do likewise.

It would appear that our present security regulations leave much to be desired in many ways. Now that the rearmament drive has started in real earnest, let us hope that the so-called "restricted" information is, in fact, restricted, but *not* to such an extent that the public hears nothing of some of our latest ventures, at least.

Harrow Weald, Middlesex. FRANCIS V. POUND.

[For *Flight*'s views on this matter we refer readers to a leading article, "Letting the Side Down," on February 8th.—Ed.]

Noisy Project

IN *Flight* of January 25th, Mr. R. Russell suggests a "Festival Railplane," to be driven by two powerful gas turbines (presumably Sapphires or Avons were envisaged), to be run as a coach between Marble Arch and the South Bank.

Now I wonder if Mr. Russell has considered the noise which would result from the running of two of these engines at a height of only twenty or thirty feet from the ground? It seems, too, that the jet efflux might have undesirable results; and surely, at the speeds at which such a project could conceivably operate, the jet unit is a highly inefficient device?

Wellington, Berks. J. R. DIXON.

Bleriot's Altitude

SOME time ago, Mr. Charles Gardner, the air correspondent of the B.B.C., came down to help me in recording a talk in which I gave some personal impressions of watching my old air friend Louis Bleriot make the first aeroplane flight across the Channel. A point which arose in discussion concerned the greatest altitude it was possible to attain in one of the little 24 h.p. three-cylinder air-cooled Anzani-engined monoplanes such as Bleriot himself used on that famous flight. And the question cropped up again when one of these machines—preserved as an historical relic—was flown by a modern pilot at recent British air displays. In these more recent tests the tiny machine seemed incapable of doing much more than just skim along a few feet above the ground.

Now, in *Flight* of February 8th (page 158), I see that A. Cdre. Wheeler comments on the claim that, during his cross-Channel flight, Bleriot reached a height of 200ft, setting against this the argument that the pilot had actually started his flight from the top of a cliff 180ft high.

Actually, however, this was not the case. I was there at the time, as Air Reporter No. 1, and what Bleriot really did was to start his flight from sand dunes at Les Baraques, mid-way between Calais and Sangatte, and from very little more than a sea-level starting-point. And during his flight (as he told me on the same evening on returning to Calais) he himself calculated that he had reached an altitude of quite 200ft or perhaps a little more. And he added that when he approached the English coast he was quite at a height of the cliff-tops, and could have made a landing on one of these cliffs. The reason he did not do so was that there was by this time a very troublesome and gusty wind blowing. This caused him to fly along level with the cliffs, a little seaward,

CORRESPONDENCE . . .

from near St. Margaret's Bay to a point near Dover Castle. And then, when he saw a break in the cliffs, just below Dover Castle, he thought his best chance was to dive in through this gap. Which he did—only, however, to make a rough landing which damaged his undercarriage and broke his airscrew.

Pilots like Bleriot and Leblanc could coax these little Anzani-Bleriots up to quite a good altitude. Not that they ever bothered much about doing so, at any rate, when on the pioneer cross-country flights of those days. Flying without maps or compasses, as they did then, their tendency was to keep pretty close to the ground in order to keep their eyes well on the railways and other prominent landmarks by which they steered their course.

Epsom, Surrey. HARRY HARPER.

Turboprop Afterburning?

READING Mr. Talbot's letter in your issue of February 1st reminded me that I have not noticed any references to the application of true afterburning to turboprops.

Could any of your readers say whether this has been tried? At first sight it would seem to offer a comparatively cheap and simple way to improve take-off and initial climb of turboprop-equipped aircraft, even though the percentage gain in power could not be so great as with afterburning turbojets.

London, S.W.11. J. C. FARQUHAR.

[Residual thrust of a turboprop after two or more turbine stages have taken power for compressor and airscrew is generally very small. If an afterburner were fitted, a variable-area nozzle would also be required to obtain propulsive efficiency. The complication and weight would not be justified by the proportionate increase in thrust.—ED.]

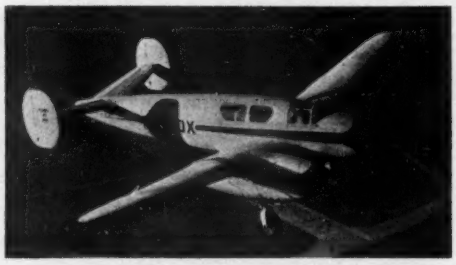
"ARTICULATED WING" RESEARCH

SOME further details are now available of the French Rey R1, several references to which have been made in these pages during recent months. Its outstanding feature is the use of articulated or floating-incidence outer wing panels which are free to move about their attachments (described as circular discs working in torsion) within deflection angle limits of 30 deg up or down. Equilibrium is maintained by an elastic linkage system. In all other respects the Rey is a conventional and attractive light twin built purely for research purposes.

Power is provided by two Renault 6QR engines, each of 220 h.p. and fitted with Ratier v.p. airscrews. Construction is of wood and the two seats are arranged in tandem. For the time being at least, the undercarriage is fixed.

The Rey's first flight, with fixed wings, was made on December 16th, 1949, the pilot being M. Leo Boyer and the flight engineer M. Marc Faure. On January 3rd this year what could be called a second first flight was made, with the floating-incidence wings in operation. Since that time it has made seven other successful flights and was to be officially demonstrated on February 13th at Melun Villaroche airfield.

The idea for this flexible-wing attachment is by no means new and, in fact, a prototype was constructed in 1940 but was subsequently destroyed during the war. Another example was constructed at the works of Société Matra, and this one flew. Both were based on the original Rey-Rouanet patents filed in 1938.



The Rey R1, built purely for research, is attractively proportioned and finished. The engines are 220 h.p. six-cylinder in-line Renaults.

The elastic linkage on the present machine is the work of engineer Arsandaux in collaboration with the Société Kleber-Colombes. Dimensions and performance details of the R1 are as follows:—

Span	43ft 2½in (13.175 m)
Length	30ft 2in (9.2 m)
Height	11ft 11in (3.65 m)
Wing area	209.8 sq ft (19.5 m²)
All-up weight	5,940 lb (2,700 kg)
Landing speed	80 m.p.h. (130 km/hr)
Maximum speed	202 m.p.h. (325 km/hr)
Climb to 1,000ft	17 min 32 sec
Ceiling	19,000ft (5,800 m)

R.Ae.C. AVIATORS' CERTIFICATES

BELOW is a further list of R.Ae.C. Aviators' Certificates, covering the period from November 27th, 1950, to January 16th, 1951. The previous list (October 20th to November 27th, 1950) appeared in *Flight* for January 11th last.

No.	Name	Club or School	Date
26,911	David Beatty Fitzpatrick	Qualified Service pilot	27.11.50
26,912	William Geoffrey Kirkman	Service pilot u/t	28.11.50
26,913	John Turnbull	Herts and Essex A.C.	28.11.50
26,914	Ronald Ian Wiseman	Strathtay Aero Club	30.11.50
26,915	Gilbert M. Goodman	Darlington Aero Club	30.11.50
26,916	Nassrollah Amir Fazli	Air Service Training, Ltd.	30.11.50
26,917	Adam Menzies Chambers	Strathtay Aero Club	30.11.50
26,918	John Wilson Christie	Strathtay Aero Club	30.11.50
26,919	Joseph William Birkle	Service pilot u/t	30.11.50
26,920	Clifford Kell	Service pilot u/t	30.11.50
26,921	Margaret Grace Hoggarth	Service pilot u/t	30.11.50
26,922	Ziad Mohammed Hamzeh	Air Service Training, Ltd.	4.12.50
26,923	Terence Claude Hembry	Qualified Service pilot	4.12.50
26,924	Barry Arthur Phillips	Qualified Service pilot	4.12.50
26,925	Donald Joseph Frederick Slimman	Strathtay Aero Club	4.12.50
26,926	Malcolm Gordon Oxford Payne	Cheltenham Aero Club	6.12.50
26,927	David Ronald Stone	Wolverhampton Aero Club	6.12.50
26,928	John Noel Bunker	Airways Aero Club	7.12.50
26,929	Anthony Ivor Alder	Service pilot u/t	11.12.50
26,930	Rupert Christopher Bailey Ashworth	Service pilot u/t	11.12.50
26,931	Peter John Giddens	Service pilot u/t	11.12.50
26,932	Roy Hollingworth	Service pilot u/t	11.12.50
26,933	Terence William Allan Smith	Service pilot u/t	11.12.50
26,934	Ronald Nelson Taylor	Service pilot u/t	11.12.50
26,935	Charles Anthony Vasey	Service pilot u/t	11.12.50
26,936	Ronald Charles Wood	Service pilot u/t	11.12.50
26,937	Maung Kyi Tin	Air Service Training, Ltd.	11.12.50
26,938	Maung Khin Kyu	Portsmouth Aero Club	11.12.50
26,939	James Wilfred Edwards	Wolverhampton Aero Club	11.12.50
26,940	David Jeffrey Long	Cambridge Aero Club	13.12.50
26,941	Samuel Ian Turner	Strathtay Aero Club	14.12.50
26,942	Victor Valentine Avila	Qualified Service pilot	14.12.50
26,943	Oswald Weisz	Air Service Training, Ltd.	14.12.50
26,944	Robert Thomas Harold Patterson	Blackpool and Fylde A.C.	14.12.50
26,945	Fredric Cady Burton	Current American licence	14.12.50
26,946	Reginald James Seggar	Strathtay Aero Club	14.12.50
26,947	Joseph Yonan	Air Service Training, Ltd.	18.12.50
26,948	Ronald George Herrington	Qualified Service pilot	18.12.50
26,949	Mohammed Hassan Masoud	Strathtay Aero Club	19.12.50
26,950	Jameel Abu Ateeg	Strathtay Aero Club	19.12.50
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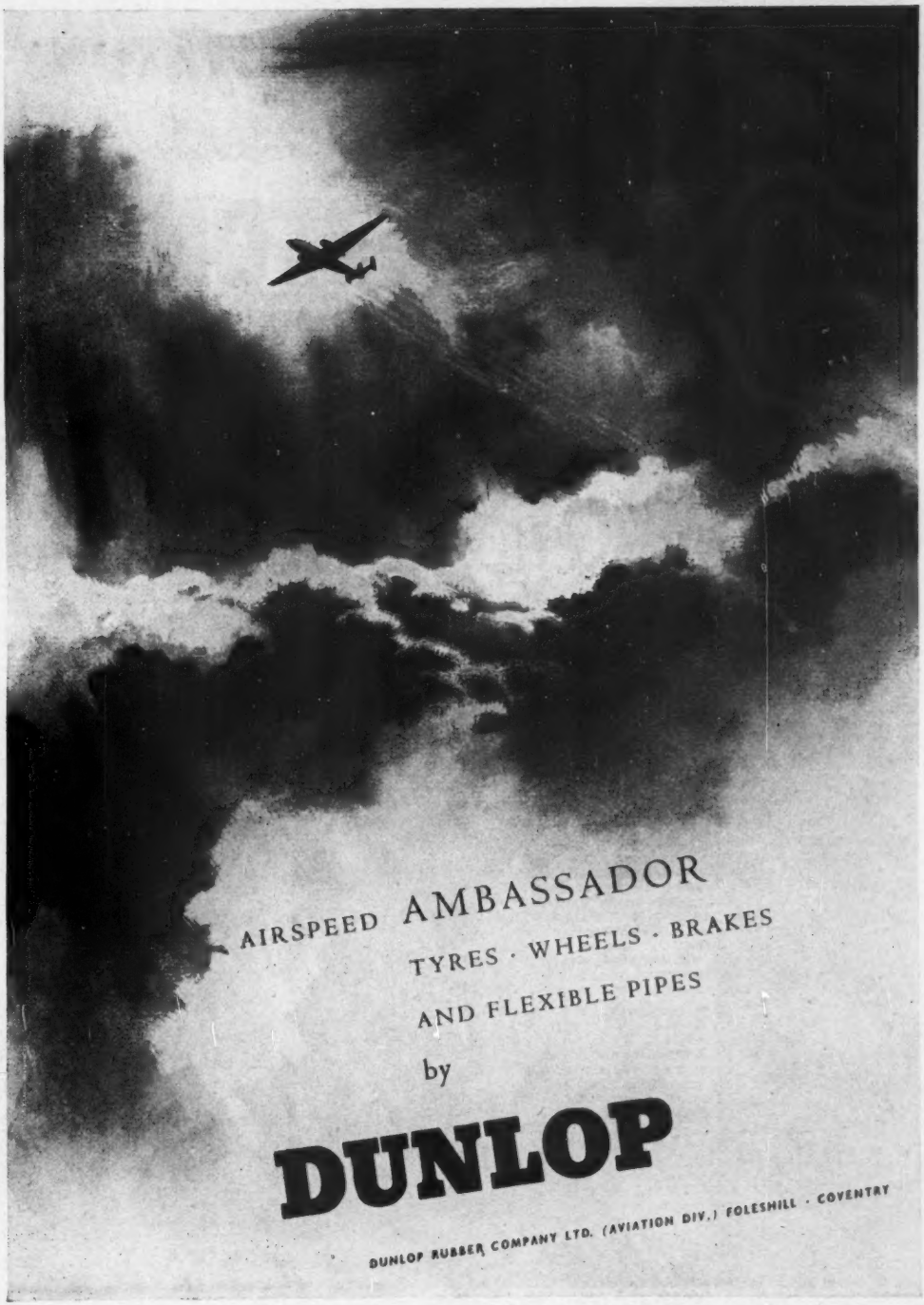
26,956	Abdullah Saleh Rahmy	Strathtay Aero Club	19.12.50
26,957	Omar Mohsin Bulkhy	Strathtay Aero Club	19.12.50
26,958	Kenneth Perrins	Qualified Service pilot	19.12.50
26,959	Michael Hughes	Service pilot u/t	19.12.50
26,960	Arthur John Rosser	Service pilot u/t	19.12.50
26,961	Roger Lawton Dimock	Service pilot u/t	19.12.50
26,962	Douglas Brian Durrant	Service pilot u/t	19.12.50
26,963	Ronald James Parsons	Luton Flying Club	21.12.50
26,964	Arthur Thomas Bint	Service pilot u/t	3.1.51
26,965	Thomas Allenby Bath	Cambridge Aero Club	21.12.50
26,966	Edmund Lamont Foyle	Rochester Flying Club (Belfast Branch)	21.12.50
26,967	George Alexander David Wilson	Rochester Flying Club (Belfast Branch)	21.12.50
26,968	Frank John James Haddock	Qualified Service pilot	1.1.51
26,969	Cyril Joseph Ashton	Liverpool Flying Club	18.1.51
26,970	Robert Horsley Golightly	Qualified Service pilot	1.1.51
26,971	Bryan Parker Helme	Airways Aero Club	4.1.51
26,972	Clive Dudley Martin	Herts and Essex A.C.	4.1.51
26,973	Ronald Henry Cunningham	Herts and Essex A.C.	4.1.51
26,974	James Dow Allan	Cardiff Aero Club	5.1.51
26,975	David John McIntosh	Herts and Essex A.C.	11.1.51
26,976	Derek Russell Bullock	Yorkshire Aeroplane Club	11.1.51
26,977	Gordon Stewart Grierson	Liverpool Flying Club	11.1.51
26,978	William Appleby	Newcastle Aero Club	8.1.51
26,979	Seiwert Marnitz Reeders	Portsmouth Aero Club	8.1.51
26,980	John Pickles	Rochester Flying Club	15.1.51
26,981	Ronald Ivor Chedgey	Rochester Flying Club	15.1.51
26,982	Leslie Wood	Service pilot u/t	15.1.51
26,983	John Tate	Tees-side Flying Club	15.1.51
26,984	Derrick Edward Gillingham	Herts and Essex A.C.	16.1.51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SERVICE AVIATION

Royal Air Force and Naval News and Announcements

COOKIES: Armourers prepare to load two 4,000-lb bombs into a B-29 Washington. This type, with the Lincoln, will continue to equip Bomber Command's "heavy" squadrons until four-jet bombers are delivered.

R.A.F.'s New Basic Trainer

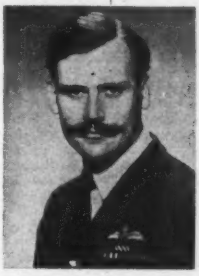
KEEN competition between two excellent aircraft characterized the recent comparative trials held to select a new basic trainer for the R.A.F. The result, announced last week, is a production contract for the Percival P.56, a two-seater powered initially by an Armstrong Siddeley Cheetah; its competitor was the Handley Page H.P.R.2. Production aircraft will have the Alvis Leonides radial de-rated, by 50 h.p., to 500 h.p. The power-output of the Leonides is exceptionally good for a basic trainer and should result in high performance and—as the unit will not be operated to its limits—long engine-life.

The P.56, which has side-by-side seating for instructor and pupil, full radio and two-stage amber, is a direct successor to the Prentice, which it will probably begin to supplant late next year.

Transatlantic Canberra

AN English Electric Canberra B.2 jet bomber, of the type now in production and soon to enter squadron service with Bomber Command, was, early this week, due to fly the Atlantic non-stop from Aldergrove, Northern Ireland, to Gander, Newfoundland. Its next stopping-point was to be Wright-Patterson Air Force Base, Dayton, Ohio, the Headquarters of the U.S.A.F. Air Materiel Command. Following evaluation trials, the Canberra is expected to go into production in America.

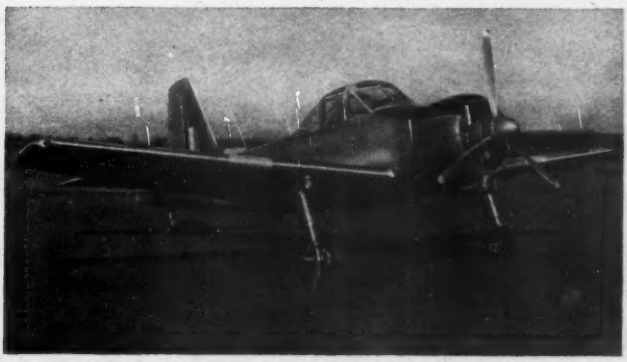
The honour of manning this aircraft—which would be the first jet to make a non-stop transatlantic journey without flight-refuelling—fell to a pilot and crew from the Aeroplane and Armament Experimental Establishment, Boscombe Down. The pilot, S/L. E. A. Callard,



S/L. E. A. Callard, D.F.C.

D.F.C., has made nearly all the initial Service test-flights of the Canberra at Boscombe. His wartime experience as a Mosquito-pilot on intruder and bomber-support duties is particularly appropriate in view of the rôle in which the Canberra will probably serve with the U.S.A.F. S/L. Callard, who is 32, joined the R.A.F. in December, 1940, and was trained in Canada, where he continued to serve as an instructor for about two years. On his return to Britain he flew two tours of operations on Mosquitoes and was later posted to the Bomber Support Development Unit.

The navigator chosen was F/L. E. A. J. Haskett, aged 30, who joined the R.A.F. as an apprentice in 1937, volunteering for aircrew duties in 1941. He made two tours of operations in Bomber Command during the war, flying with Nos. 5, 7, 8, 10 and 96 Squadrons. The signaller selected was 29-year-old F/L. A. J. R. Robson, who joined the R.A.F. in 1940 as a wireless-operator/air-gunner. He also served with Bomber Command during the war.



CHOSEN: As reported above, the Percival P.56 has been selected as the new R.A.F. basic trainer. Production versions of the P.56 will have the Alvis Leonides 500 h.p. radial engine.

New Reserve Units

FOUR regular squadrons of Fighter Command are being released for first-line duties by an Air Ministry scheme—now coming into operation—for sub-contracting anti-aircraft co-operation work to civilian operators. When the plan is in full operation, it is expected that five civil units at points in England and Wales will be employing 70 aircraft in this work—target-towing and flying across A.A. ranges at various speeds and heights. The aircraft are of various types—mainly Oxfords, Beaufighters, Spitfires and Vampires—and will normally be taken over from the Service squadrons now in existence.

No. 1 C.A.A.C.U. (Civil Anti-Aircraft Co-operation Unit) is, in fact, already being operated by Short Brothers at Hornchurch; its work consists primarily in giving practice to the Navy's gun-crews at Chatham. The A.A. units will be run on the same lines as the civilian-operated reserve flying schools of Home Command. All pilots will be members of reserve formations, such as the R.A.F.V.R. or R.A.F.R.O.

Lord Tedder to leave Washington

WITH effect from next April, Marshal of the R.A.F. Lord Tedder is to be succeeded by Air Marshal Sir William Elliot as chairman of the British Joint Services Mission in Washington and British representative on the standing group of the N.A.T.O. military committee. On his return to Britain, Lord Tedder, who retired from the R.A.F. as C.A.S. last year, is expected to take up two appointments: as Chancellor of Cambridge University and as a governor of the B.B.C.

Air Marshal Sir William Elliot, who is 54, has been Chief Staff Officer to the Ministry of Defence and Deputy Secretary

SERVICE AVIATION . . .

(Military) of the Cabinet since April, 1949. He had previously been A.O.C.-in-C., Fighter Command, for over two years.

Class G Call-up

GOOD progress is being made by the R.A.F. Records Office at Gloucester in organizing the call-up, this summer, of 10,000 members of Class G Reserve for service with control and reporting units. By the end of last week, 7,000 men had replied to the preliminary warning notices; only a small percentage had given notice of appeal.

Appointed to Air Ministry

AIR COMMODORE D. N. Roberts, O.B.E., A.F.C., who has been president of the R.A.F. Selection Boards at Ramridge House, Andover, since October, 1949, has been appointed to the Air Ministry as Director of Operations (2), with effect from March 1st.

On April 1st, A.Cdre. W. J. M. Akerman, C.B.E., also takes up a new appointment at the Air Ministry—as Director of Organization (Establishments). Since July, 1949, A.Cdre. Akerman has commanded No. 65 (London Reserve) Group, Home Command.

Mediterranean Rescue

ON February 12th, the first day of the Anglo-American Naval exercises in the Mediterranean, a U.S.N. pilot was rescued 90 miles from his carrier by the British destroyer *St. Kitts* (Cdr. G. A. G. Ormsby, D.S.O., D.S.C.). The pilot, Lt. R. E. Davis, was forced by engine trouble to ditch in the Tyrrhenian Sea, off the S.W. coast of Italy. Other members of his search-and-attack squadron circled overhead while the R.N. task force was notified of his position. Lt. Davis was picked up from his dinghy after about an hour.

Both the Home and Mediterranean fleets, together with the U.S. Sixth Fleet, have been taking part in the exercises—the largest since the war. The two British carriers involved were the *Indomitable* and *Indefatigable*.

Cold-Weather Trials

NOW in America as R.A.F. representatives at the joint U.S.-Canadian trials of cold-weather flying equipment are W/C. A. J. Barwood, of the R.A.F. Institute of Aviation Medicine, and Mr. J. Pragnall, Mechanical Engineering Department, R.A.E.

Experimental survival equipment and rations for use in Arctic conditions have been tested by the R.A.F. in field conditions in Canada and Norway in recent years. The equipment now under test in North America, which includes a full range of cold-weather clothing, sleeping bags, various types of rations, as well as many accessory items, incorporates improvements made as the result of the earlier trials.

The headquarters base for the trials is the R.C.A.F. Winter Experimental Establishment at Edmonton, Alberta, and field work will be carried out at the U.S.A.F. bases of Fort Churchill and Fort Nelson, Alaska. W/C. Barwood won the 1950 L. G. Groves Memorial Prize for Aircraft Safety with his essay, based on research in the laboratory and practical studies in the field, which made an outstanding contribution to the protection of aircrews against temperature and climate.

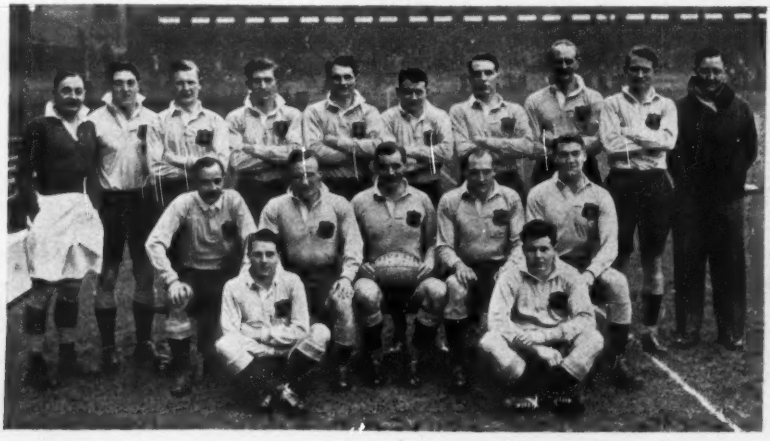
LOCAL PRODUCT: A prototype Bristol 171 Sycamore helicopter, bearing Service insignia, was used in Exercise "Medusa," held recently in the Bristol area to give the Army and Civil Defence practice in co-operation during an atomic attack. Seen after his arrival by helicopter is Col. J. T. Gough of the Royal Armoured Corps.

Reunions

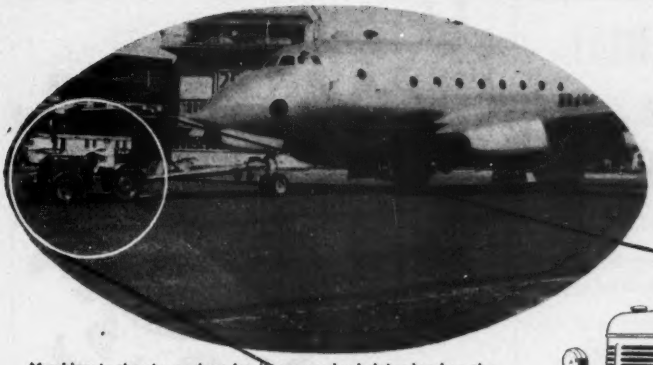
NO. 201 Squadron Dinner Club.—Dinner at Londonderry House, 19 Park Lane, London, W.1, at 1930 hr on Friday, April 20th. Details from the Secretary, R.A.F. Pembroke Dock, South Wales.

* * *

No. 780 Naval Squadron (inadvertently referred to as 708 Squadron in a recent issue).—Fifth annual reunion dinner at Simpsons-in-the-Strand, London, on Friday, March 2nd. Details from H. T. Molyneux, Sarre Court, Sarre, near Birchington, Kent.



R.A.F. RUGGER TEAM: Members of the R.A.F. Rugby XV, which lost narrowly to the Navy during the recent match at Twickenham: (back row) Mr. Yorston, referee; A/C. D. M. Rose; Sgt. P. M. Davies; A/C. R. E. Syrett; O/Cdt. S. D. Little; F/L. R. J. H. Uprichard; F/L. N. J. Carver; F/L. P. G. Yarranton; F/O. R. B. George; W/C. S. G. Walker (touch judge); (seated) S/L. F. W. Higginson; F/L. W. T. H. Hay; S/L. R. H. G. Weighill (captain); Cpl. E. E. Rossiter; F/O. S. T. H. Wright; (front row) A/C. Glyn John; P/O. K. J. Dalgleish.



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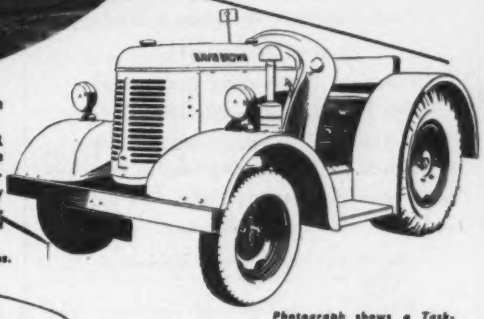

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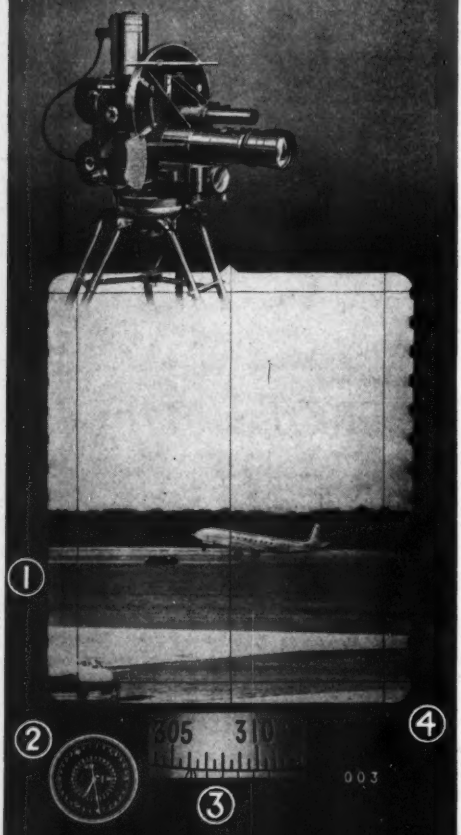

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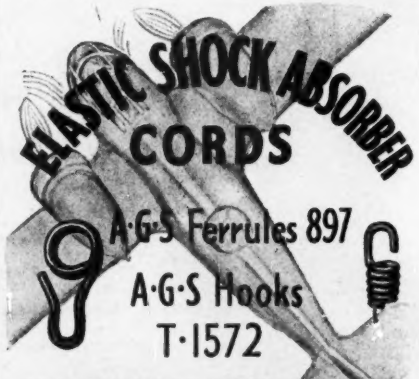

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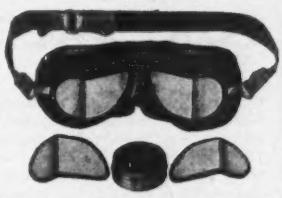

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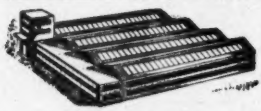

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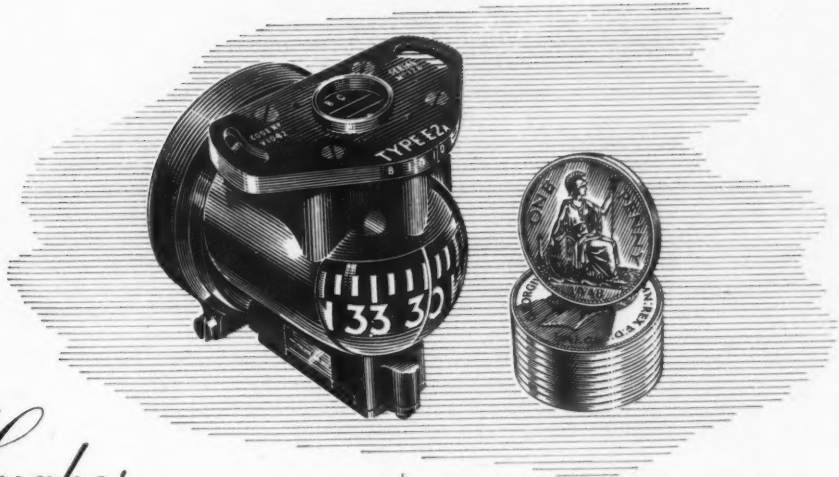

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